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Liquidity needs and vulnerability to financial underdevelopment ☆

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Abstract

This paper provides evidence that financial development has a large causal effect in the reduction of macroeconomic volatility resulting from the role of the financial system in liquidity provision. In particular, financial system development leads to a comparatively larger reduction in the volatility of output in sectors with high liquidity needs. Most of this decline results from the stabilization of the output of existing firms, although the volatility of the number of firms also drops significantly. Among different aspects of the financial system, the depth of financial intermediaries plays the main role in the reduction of volatility.

JEL classification: G2; O16; E32

Keywords: Financial development; Economic volatility; Liquidity needs

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1. Introduction

Does the development of a country's financial system affect its vulnerability to crises? Recent literature focusing on the impact of the East Asian crisis among countries and firms with different qualities of corporate governance suggests that weak financial institutions can significantly increase the effect of external shocks. Johnson et al. (2000) show that, among emerging markets, the extent of exchange rate depreciation and stock market decline during the period encompassing the Asian and Russian crises was larger in countries with poor corporate governance. Mitton (2002) shows that, in four countries affected by the Asian crisis, stock prices performed significantly better in firms with better corporate governance indicators. Similar evidence is provided in a recent paper by Baek et al. (2004) which reports that the concentration of ownership among foreign investors significantly reduced the impact of the Asian crisis among Korean firms. Moving beyond specific aspects of corporate governance, Easterly et al. (2000), Denizer et al. (2002), and Beck et al. (2001c) use aggregate data to explore the relation between financial development and output volatility and find that a more developed financial system is associated with decreased output volatility across countries.

This evidence is challenged by Acemoglu et al. (2003), however, who find that financial aspects do not matter for crises after controlling for institutions. According to this view, it is a country's institutional development that is simultaneously driving its vulnerability to shocks and its quality of corporate governance and financial development. Their result sheds some doubt on the true mechanism behind the cross-country studies cited above, and although it does not apply directly to the papers that exploit cross-firm variation, it casts doubt on the generality of their conclusions.

This paper provides new evidence that the development of the financial system has a causal effect on output volatility. The methodology involves data on 70 manufacturing industries in 48 countries during the period 1981–1998, and exploits the industry variation of the data to test the implications of a specific mechanism by which financial development can affect the extent of fluctuations, namely, the provision of liquidity to firms suffering working capital problems.

Many theoretical models imply that financial development reduces volatility because it helps firms facing temporary cash flow or net worth problems to obtain the necessary working capital to finance their operations (see, for example, Caballero and Krishnamurty, 2001). According to this mechanism, financial development should lead to a relatively larger reduction in the volatility of firms in industries that are more likely to require external funds to operate, that is, industries with high liquidity needs. This differential effect across industries provides the grounds on which to build an indirect test of causality. Evidence that financial development leads to a relatively greater reduction in the output volatility of industries with high liquidity needs provides indirect but strong support for a causal role of financial development in the reduction of output volatility through liquidity provision. Most important, the cross-country, cross-industry aspect of the data permits the generality of a cross-country analysis and the econometric advantages of cross-firms, country-based studies, therefore simultaneously complementing the evidence from both strands of the literature discussed above. The focus on a specific mechanism permits distinguishing among alternative explanations for the findings and determining whether the results are spuriously driven by a general impact of institutions on volatility that operates independently of financial development. Of course, this does not imply that the

effects of institutions and financial development on volatility can be completely separated because, as suggested by the findings of Acemoglu and Johnson (2004), institutions such as property rights are also likely to have an impact on financial development.

Following the methodology of Rajan and Zingales (1998), I build a measure of the liquidity needs of different industries using U.S. data, which I use to test the hypothesis that financial development leads to a relatively larger reduction in the volatility of industries with higher liquidity needs. I do this by estimating a regression of industry volatility (measured in the benchmark specification by the standard deviation of the growth of real value added) on the interaction between an industry's liquidity needs and a country's financial development (captured by the level of private credit to GDP) controlling for country and industry fixed effects and other determinants of volatility.

The results show that financial development significantly reduces the relative output volatility of industries with high liquidity needs, providing strong support for the presence of a causal link from financial development to volatility. The difference in the standard deviation of real-value-added growth between the electrical machinery industry and the paper boxes industry (located at the 75th and 25th percentile of liquidity needs, respectively) would fall five percentage points if a country with the financial development of Egypt reached the financial development of Spain (countries located at the 25th and 75th percentile level of financial development, respectively). This decrease in volatility corresponds to 68% of the aggregate interquartile range of volatility across sectors.

A simple estimation of the effect of financial development on aggregate volatility based on the sector results suggests that, under plausible assumptions, this effect is important at the macroeconomic level. For example, if a country like Egypt reached Spain's level of financial development, the standard deviation of its aggregate manufacturing value added could fall from seven to six percentage points, a 14% fall in volatility that would close 56% of the volatility gap between Egypt and Spain (1.8 percentage points). In this sense, the results suggest that the difference in aggregate volatility between Egypt and Spain could be explained to a large extent by the difference in their financial development.

These simple calculations also suggest that an important part of the effect of financial development on macroeconomic volatility previously documented in the macro-finance literature could potentially be explained by the impact of financial development on sector volatilities estimated in this paper. A back-of-the-envelope calculation suggests that an increase in the level of private credit corresponding to 50% of GDP could result in a one percentage point decline in the standard deviation of real GDP per capita. This magnitude is about 80% of the value estimated by Denizer et al. (2002) for a similar increase, and 50% of the effect estimated by Easterly et al. (2000). Without pretending that this rough estimation provides an accurate measure of the impact of financial development on aggregate macroeconomic volatility, given the assumptions required to extrapolate from the sector results to the aggregate, these results confirm that the implied effect is of the right order of magnitude, and that the aggregate impact is likely to be economically significant.

The main results of the paper are robust to a battery of tests including changes in the specific measure of liquidity needs, volatility, and financial development, and also to the consideration of alternative explanations of the basic findings that include the possibility that financial development is spuriously capturing the effect of general institutions on volatility suggested by the results of Acemoglu et al. (2003). It is important to notice, however, that despite its broad coverage, the sample of countries is biased towards

middle- and high-income countries. While 60% of high-income countries and 25% of middle-income countries are represented in the sample (covering 92% and 44% of the aggregate output in each income group, respectively), only 15% of poor countries, representing 34% of total GDP of this group, is included. The reason for this bias is that industrial data at the level of disaggregation used in this paper is typically unavailable for poor countries. One must therefore be cautious about extending the conclusions of this paper to countries at the bottom of the world income distribution.

The paper also explores whether the reduction in volatility associated with financial development is achieved mainly through a decline in the volatility of output per firm, the volatility of the number of firms, or the covariance between these two components. The evidence shows that financial development reduces both types of volatility, but that its impact on the volatility of output per firm is considerably larger. The effect on the covariance is positive but small, suggesting that financial development slightly increases the probability of scenarios in which output per firm and the number of firms grow or decline together.

Additional regressions provide some interesting results on the effect of the financial structure (banks versus markets) on volatility, which add to the existing literature on financial structure and growth (Levine and Zervos, 1998; Beck et al., 2001a). These results show that the development of banks is more important than the development of stock markets in reducing the relative volatility of sectors with large liquidity needs. This finding is consistent with the idea that banks are more important for the provision of liquidity (in the form of credit lines, etc.) than arms-length markets, especially in less financially developed countries.

This paper is related to several strands of literature. At a general level, it relates to the extensive literature on financial development and growth started by King and Levine (1993). The evidence reported here suggests that financial development affects not only the mean growth level but also its standard deviation. Hence, financially developed countries can enjoy higher and more stable growth rates. The paper is also part of a recent literature that emphasizes the heterogeneous effects of financial development (see for example Rajan and Zingales, 1998; Braun, 2003; Vlachos and Svaleryd, 2005; Beck, 2000). It adds to this literature by showing an additional manner in which financial development can have a distributional impact, and confirming that the aggregate effect of financial development is tied to the productive structure. Finally, a recent study by Braun and Larraín (2005) builds on the results of this paper and analyzes the effect of financial development on the cyclical fluctuations of different industries over time. The use of the time dimension allows them to separately identify the effect of recessions from the effect of booms, but requires them to assume that aggregate fluctuations are exogenous to industry-level fluctuations, which is a strong assumption given the small number of industries considered in their study (28 versus 70 considered here). This paper focuses instead on the impact of financial development on unconditional volatility and other moments of the unconditional distribution of growth rates (such as the depth of the worst output experience), which does not require explicit identification of recessions and expansions. Also, from a theoretical standpoint, this paper emphasizes the needs of an industry for liquid funds in the short run as the main determinant of its vulnerability to financial conditions, while Braun and Larraín use the Rajan and Zingales (1998) measure of external dependence, which is mainly aimed at capturing a firm's long-run requirements for external funds as a source of physical capital formation. As will be shown later, the Rajan and Zingales measure tends to appear

insignificant after controlling for the liquidity needs of an industry. Nevertheless, the results of both papers are in accord.

The rest of the paper is organized as follows. Section 2 discusses the theoretical argument behind the basic hypothesis that financial development reduces the relative volatility of sectors with large liquidity needs and its relation to the causal link between financial development and volatility. Section 3 describes the empirical strategy used to estimate the effect of financial underdevelopment on the volatility of sectors with different relative liquidity needs. Section 4 describes the measures of liquidity needs, financial development, and volatility used in the paper. Section 5 presents the main results, documenting the relation between financial development and liquidity needs across sectors, and showing that sectors with larger liquidity needs are relatively more volatile in less financially developed countries. Section 6 presents several extensions to the main results. Section 7 discusses the robustness of the results. Section 8 concludes.

2. Theoretical background

Many theoretical models have shown that credit market imperfections can amplify the effect of macroeconomic shocks (e.g. Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997). In most of these models, information asymmetries (like moral hazard or costly state verification) induce borrowers and lenders to write contracts in which the maximum amount that can be borrowed depends on a borrower's net worth. Clearly, this particular characteristic of financial contracts under asymmetric information can amplify the effect of shocks. In a perfect financial market, a temporary demand or productivity shock that does not affect a borrower's expected profitability will have no impact on its ability to borrow, even if it affects its current net worth. However, with credit market imperfections, the contemporaneous decline in net worth will reduce the ability of the borrower to invest in physical and working capital, causing a decline in future output. Moreover, the decline in future output represents, ceteris paribus, a decline in future net worth that reduces tomorrow's ability to borrow with respect to the perfect capital markets case, perpetuating the initial effects of the otherwise temporary shock. Most of these models focus on investment in fixed assets, but it is clear that their results can be directly extrapolated to working capital investment. The latter is arguably more important for short-run volatility because we know from micro evidence that investment in fixed assets is lumpy and infrequent (Caballero et al., 1995).

These theoretical models of credit market imperfections and amplification provide the foundation for the literature on financial development and volatility. The underlying idea is that the level of financial development is related to the importance of credit market imperfections in a country. A more developed financial market provide borrowers and lenders with better tools (debt instruments, contracts, etc.) to deal with the information asymmetries that naturally arise in financial relations. In this way, financial development reduces the dependence of these contracts on a borrower's net worth, therefore reducing their role on the amplification of shocks and the overall degree of volatility. In fact, several papers directly model the degree of financial development in reduced form as affecting the amount a firm can borrow for a given level of cash flow or net worth (e.g., Aghion et al., 1999; Caballero and Krishnamurty, 2001).

A common prediction of these models is that, in an underdeveloped financial system, a firm that experiences a temporary negative shock to its cash flow could see its future output

severely reduced because of its inability to raise funds to finance its working capital. This suggests that the relaxation of financial constraints associated with a higher level of financial development should relatively benefit, in terms of reduced volatility, firms in industries that typically require high amounts of liquid funds to operate, as these are firms that are more likely to require external funds to finance their liquidity needs when affected by negative shocks (Appendix A presents a simple model that formalizes this story). Finding evidence of these sector differences in the data would therefore provide indirect but strong support for the presence of a causal effect of financial development on volatility. That is precisely what this paper does.

There are two relevant theoretical issues that must be addressed before moving to the empirical strategy. The first is that, even though the relation between the extent of credit market imperfections and volatility is clear in the literature, there is an argument that financial development can actually increase volatility by increasing the leverage of the typical firm and making it more vulnerable to shocks (see Kaminsky and Schmukler, 2003, and references therein). The second issue is the argument that firms in financially underdeveloped countries might hoard liquid assets to deal with potential future shortages in working capital, especially those firms with high liquidity needs. From an empirical point of view, of course, both of these potential problems would bias the results against finding any significant relation between financial development and the relative volatility of industries with high liquidity needs. Therefore, finding such a relation despite these potential problems further strengthens the evidence in favor of the channel emphasized in the previous discussion.

3. Empirical strategy

The hypothesis that financial development has a relatively greater impact on the volatility of industries with high liquidity needs can be tested by estimating the parameters of the following specification:

$$V_{i,k} = \alpha_k + \beta_i + \gamma L_i \mathrm{x} F_k + X_{i,k}\delta + \varepsilon_{i,k}, \tag{1}$$

where $V_{i,k}$ is the volatility of industry i in country k, α_k is a country-specific effect, β_i is an industry-specific effect, L_i is the measure of liquidity needs of the industry, F_k is the measure of financial development of the country, $X_{i,k}$ is the set of additional determinants of sector volatility, ε_{ij} is a random error, and δ and γ are parameters to be estimated. The parameter of interest is γ, or the effect of the interaction of financial development and liquidity needs on volatility. If financial development leads to a relatively greater reduction in the volatility of sectors with high liquidity needs, then γ should be negative and economically significant.

Several characteristics of this specification deserve further discussion. First, the specification includes industry- and country-specific effects (α_k and β_i). The inclusion of these fixed effects controls for any determinant of volatility that varies across countries or industries (e.g., inflation, terms of trade volatility, commodity dependence, etc.) and significantly reduces the concerns about omitted variable bias and reverse causality that are common to cross-country regressions. The reason is that, in presence of these fixed effects, the results could only be biased by an omitted variable that varied through both countries and industries and was correlated with the interaction of liquidity needs and financial development. This is clearly less plausible than having an omitted variable

correlated with the *level* of financial development, which is sufficient to bias the results in the cross-country case. With respect to reverse causality, the presence of the fixed effects controls for any potential feedback from the level of volatility to the level of financial development, which is the main argument for the presence of reverse causality in cross-country regressions.

Another important aspect of the specification is that liquidity needs are considered industry specific (they do not vary across countries). This assumption is standard in the Rajan and Zingales (1998) methodology, and its economic justification will be discussed in Section 4.1. Nevertheless, if liquidity needs are only imperfectly correlated across countries, the assumption that they are industry specific would induce an attenuation bias in the γ coefficient. The reason is that any benchmark measure based on a specific country is a noisy measure of true liquidity needs. The only case in which the assumption of industry-specific liquidity needs could bias the results in the opposite direction is when liquidity needs depend on the level of financial development. However, even in this case, there would be a bias only if the sensitivity of different industries to the level of financial development were correlated with the level of the benchmark measure of liquidity needs-that is, if industries with a high measure of liquidity needs have a high sensitivity to financial conditions. This possibility cannot be totally disregarded, but there is no compelling economic reason for it to hold. Moreover, even in this case, the sign of the bias is likely to go in the right direction if the variance of financial development is larger than the covariance between the level of financial development and its square, which is likely the case, especially when financial development is measured as the deviation from the mean across countries as is implicitly the case when country fixed effects are included in the specification.

The measure of financial development will also likely contain error and induce an attenuation bias. Financial development is a broad economic concept that can only be partially captured with any specific measure. Some possible sources of error are discussed in detail in the next section.

Regarding the estimation methodology, the simplest way to proceed would be to estimate the parameters of Eq. (1) by ordinary least squares (OLS). However, the previous considerations suggest that the OLS coefficient would likely be biased toward zero because of the possibility of measurement error in liquidity needs (in the case of imperfect correlation) and financial development. For this reason, it is important to estimate the parameters by Two Stage Least Squares (2SLS), thus reducing the parameters' bias. The details of the 2SLS procedure, including the specific instruments used, are discussed in Section 4.3.

4. Measuring liquidity needs, financial development, and volatility

4.1. Liquidity needs

4.1.1. Methodological aspects

Firms in industries that require relatively large amounts of working capital will typically be more dependent on the availability of liquid funds from either internal or external sources. This suggests that the liquidity needs of an industry can be estimated by measuring its relative dependence on working capital. However, there are two problems with such a measure. First, there are no comprehensive data that could be used to build a

country-industry specific measure of liquidity needs. Second, even if data were available, a firm's dependence on internal sources of liquidity to finance working capital will likely be affected by the characteristics of the financial system in which they operate. These data could be contaminated precisely by the effect of financial systems for which this paper attempts to test.

It is thus necessary to follow an indirect approach. This paper builds a measure of the liquidity needs of an industry by applying the methodology of Rajan and Zingales (1998). The application of this methodology requires two basic assumptions. First, there is a technological reason why some industries use relatively more working capital than others. Second, these technological differences persist across countries. The first assumption can be justified by noting that differences across industries in the length of the production process and the mode of operation (batch versus continuous) that are likely to affect their relative use of working capital are mainly technological.[1] Regarding the second assumption, the use in this paper of narrowly defined industries should reduce the scope of variation in technologies across countries. Moreover, as will be shown in the next section, measures of the liquidity needs of different industries are highly correlated across those countries for which there are data available. This finding provides additional support for the claim that technological factors are important determinants of the liquidity needs of an industry.

Under these assumptions, a measure of the liquidity needs of an industry can be built using U.S. data and then extrapolated to other countries. Moreover, the assumptions can be significantly relaxed without affecting the power of the tests based on the U.S. measure. For example, as noted by Rajan and Zingales (1998), the estimator of γ based on the U.S. measure of liquidity needs will be unbiased if the ranking of liquidity needs is preserved across countries. Moreover, as discussed in Section 3, if the liquidity needs of an industry in the U.S. and the same industry in other countries are correlated, the OLS estimator of γ based on the U.S. measure would be most likely biased toward zero, stacking the cards against finding any significant result.

The assumptions discussed above help to overcome the lack-of-data problem, but do not deal with the relation between financial markets and observed levels of working capital. This problem is solved largely by using data from relatively large U.S. companies to build the measure of liquidity needs. There are two reasons for this: first, the U.S. is one of the most developed financial markets in the world, so financial constraints should be less important for U.S. firms than for firms in other countries; and second, within the U.S., large firms are less likely to be constrained in their access to external liquid funds (Fazzari et al., 1988; Gertler and Gilchrist, 1994). In other words, by focusing on large U.S. corporations, we can assume that the supply of liquid funds is almost perfectly elastic; therefore, we can assume that observed differences in relative working capital levels across industries are mainly demand driven. Using data from large companies introduces the new concern that their technology could be different from that used by small firms, but this too can be considered a measurement error problem, and its impact on the estimated parameters would be to bias them toward zero.

[1]Some papers emphasizing the role of the length of the production process and other technological characteristics as determinants of working capital demand include Ramey (1989), Kim and Srinivasan (1988), and Nunn (1981). This relation has also been pointed out by Keynes (1930).

4.1.2. The measure

The measure of liquidity needs was built using balance sheet data of U.S. public manufacturing firms from Compustat. Balance sheet data do not provide information on the ongoing amount of liquid funds that a firm invests to finance its operations, which corresponds to the economic concept of working capital. They only report the different components of the stock of liquid assets and liabilities of a firm. Hence, only a proxy of the relative importance of working capital can be obtained.

The proxy used in the main results of this paper is the ratio of *inventories to sales*, which captures the fraction of inventory investment that can be typically financed with ongoing revenue. A higher value of this ratio means that a smaller fraction of inventory investment can be financed by ongoing revenue and therefore represents a higher level of external liquidity needs. (Measures of cash flow already discount the expenditure on materials that are part of inventory investment, so sales is the appropriate measure of ongoing revenue.) Among the components of working capital investment, inventories are particularly suitable for capturing the technological aspect of liquidity needs: firms need working capital because goods take time to produce, and it is reasonable to expect that the longer the production process the larger is the value of inventories. This link to technology is unlikely to be important for other components of a firm's liquid assets (e.g., cash stocks). Of course this is conjectural, as there are no data available on the length of the production process for different industries. Another important determinant of the level of inventories is the degree of demand uncertainty. Under this interpretation, the relative importance of inventories might be capturing not only the average level of liquidity needs of a sector but also the volatility of these needs. This interpretation is formally tested by adding the interaction between a measure of industry volatility and financial development (see Section 7.2).

The precise measure was computed in the following way. First, the median ratio of total inventories to sales (Compustat #3 divided by Compustat #12) was computed for each manufacturing firm over the period 1980–1989. Next, the median ratio across firms in the same four-digit ISIC (International Standard Industrial Classification) industry was assigned to that industry. I assume that, in equilibrium, the inventory stock is renewed in each production period so the observed inventory stock captures the equilibrium level of inventory investment. This is a reasonable assumption because the available data come from annual balance sheets.

There are two potential problems with the use of the inventory-to-sales ratio as a measure of liquidity needs. First, this ratio is higher for durable-goods industries, which are relatively more volatile. Because average volatility is negatively correlated with the level of financial development, one may wrongly attribute the relation between durability and volatility to liquidity needs. This concern will be addressed by adding appropriate controls, and it will prove to be unimportant (see Section 7.2). Second, the ratio of inventory to sales has been slightly decreasing in the U.S. since the early 1980s (see Blanchard and Simon, 2000; Kahn et al., 2001). However, this trend has not significantly affected the ranking of liquidity needs across sectors; for example, the rank correlation between the ratio of inventories to sales across industries in 1971 and 1999 is 0.64 and highly significant. Nevertheless, this concern will also be appropriately addressed by estimating the main coefficients using alternative measures of the ratio of inventory to sales built using data for the periods 1970–1979 and 1990–1999, and it will prove to be irrelevant (see Section 7.1).

The following alternative proxies of the level of liquidity needs and short-run external liquidity dependence were built to check the results obtained with the main measure: (i) the *cash conversion cycle* (henceforth CCC), which corresponds to the average age of inventories plus the average age of accounts receivable minus the average age of accounts payable (inventories $*$ 365/cost of goods sold + account receivables $*$ 365/sales − accounts *payable* $*$ 365/cost of goods sold). This measure estimates the length in days between the moment a firm pays for its raw materials and the moment it is paid for the sale of its final output during the normal course of operations (see Richards and Laughlin, 1980), and it is commonly used in financial analysis to measure the liquidity position of a firm; (ii) the ratio of *labor cost to sales*, which measures the ability of a firm to finance its ongoing labor costs from its sales revenue;[2] (iii) the ratio of *short-term debt to sales* (Compustat #206 divided by Compustat #12), which captures both the actual use of external liquidity and the ability of a firm to pay its current liabilities out of ongoing income; and (iv) the Rajan-Zingales measure of long-run *external dependence*. The cash conversion cycle and the ratio of short-term debt to sales were computed using Compustat data in a similar fashion to the inventory-to-sales ratio. The measure of external dependence was computed as described in Rajan and Zingales (1998). The labor-cost-to-sales ratio was built using data from the NBER Productivity Database (Bartelsman et al., 2001) because most Compustat firms do not report data on wage payments or labor expenditures. The measure corresponds to the median ratio across the four-digit SIC industries associated with each four-digit ISIC industry (there are about 81 four-digit ISIC industries and 460 four-digit SIC industries).

Table 1 presents the ratio of inventories to sales for the 70 four-digit ISIC sectors considered in the analysis (Column 1) along with the alternative measures of liquidity needs described above (Columns 2–5). The table is sorted by the inventory-to-sales ratio, so sectors with low liquidity needs are at the top of the table. In 11 of the 81 non-inclusive four-digit-ISIC sectors there are data for fewer than five firms.

The table shows that, as previously discussed, sectors with low (high) liquidity needs are mainly non-durable (durable) goods industries. Because durable goods tend to be more elaborate, this is consistent with the argument that industries with longer production processes have greater liquidity needs. The only exception is the presence of some non-durable industries among the sectors with the largest liquidity needs. Most of these cases correspond to sector 3200, which includes the textiles, wearing apparel, and leather industries. These sectors still remain at the bottom of the table when the average level of inventory over assets during a year is measured using quarterly data, so the high liquidity needs measured for these sectors are not the result of seasonality. The results of the paper are not affected by the exclusion of these sectors.

The correlations between the inventory-to-sales ratio and the four other measures of liquidity needs are reported at the bottom of Table 1. The correlations are generally positive and significant. The average time elapsed between the moment a firm pays for its inputs and the moment it is paid for its output is significantly longer in industries with higher inventory-to-sales ratios. Sectors with high inventory-to-sales ratios also tend to have higher ratios of short-term debt to sales (so their actual use of external funds for liquidity purposes is higher), higher labor expenditures (as a fraction of sales), and higher

[2]An additional reason for this relation is, as argued by Kremer (1993), that the average worker in firms producing complex products tends to have more human capital. This induces a potential correlation between labor expenses and the length of the production process.

Table 1
Measures of liquidity needs for four digit ISIC industries

The table reports the values of the following measures of liquidity needs. *Inventories over sales* (Column 1) is the median ratio of total inventories to annual sales for U.S. corporate firms in each four-digit ISIC industry during 1980–1989. *Cash Conversion Cycle* (Column 2) is a measure of the time elapsed between the moment a firm pays for its inputs until it is paid for the goods it sells. It is defined as inventories $*$ 365/(cost of goods sold) + account receivables $*$ 365/(total sales)−account payables $*$ 365/(cost of goods sold), and the value reported corresponds to the median of this indicator across U.S. corporate firms in each four-digit ISIC industry during 1980–1989, in hundreds of days. *Short-term debt to sales* (Column 3) is the median ratio of notes to annual sales across U.S. corporate firms in each four-digit ISIC industry during 1980–1989. *External Dependence* (Column 4) is the extension of the Rajan-Zingales measure to four-digit ISIC. Data to build these four measures come from Compustat and CRSP. Finally, *Labor costs to sales* (Column 5) is the median of the ratio of labor costs to shipments among those four-digit SIC industries that are related to the corresponding four-digit ISIC industry. This measure was built using data from the NBER productivity database (Bartelsman et al., 2001). The correspondence between SIC and ISIC classification systems was made by the author. **: Significant at 1% level; *: significant at 5% level.

ISIC	Description	Inventories over sales	Cash conversion cycle	Short-term debt over sales	External dependence	Labor costs over sales
		(1)	(2)	(3)	(4)	(5)
3112	Dairy products	0.05	0.20	0.00	0.41	0.06
3117	Bakery products	0.06	0.44	0.01	−0.05	0.16
3134	Soft drinks	0.06	0.41	0.00	−0.47	0.12
3530	Petroleum refineries	0.06	0.19	0.01	0.03	0.02
3133	Malt liquors and malt	0.07	0.27	0.00	−0.20	0.09
3111	Slaughtering and preserv. meat	0.08	0.43	0.02	−0.02	0.10
3420	Printing, publishing and allied	0.08	0.78	0.00	0.20	0.28
3411	Pulp, paper and paperboard	0.11	0.68	0.00	0.12	0.16
3121	Food products n.e.c.	0.11	0.55	0.03	−0.53	0.09
3116	Grain mill products	0.11	0.54	0.03	0.04	0.07
3513	Synthetic resins and plastic	0.11	0.73	0.01	0.21	–
3843	Motor vehicles	0.11	0.55	0.02	0.72	0.18
3699	Non-metallic mineral prod. n.e.c.	0.12	0.84	0.00	−0.09	0.19
3419	Pulp, paper and paperboard n.e.c.	0.13	0.83	0.01	0.06	0.17
3551	Tyre and tube industries	0.13	0.88	0.01	−0.11	0.20
3529	Other chemical products	0.13	0.96	0.01	0.02	0.13
3412	Boxes of paper and paperboard	0.13	0.74	0.00	−0.07	0.17
3119	Chocolate and sugar confect.	0.14	0.82	0.01	−0.32	0.10
3311	Sawmills and other wood mills	0.14	0.78	0.00	0.20	0.19
3560	Plastic products n.e.c.	0.14	0.84	0.01	0.31	0.18
3512	Fertilizers and pesticides	0.14	0.96	0.02	0.10	0.10
3115	Vegetable and animal oils	0.14	0.82	0.05	0.01	0.05
3511	Basic industrial chemicals	0.14	0.96	0.00	0.35	0.09
3720	Non-ferrous metal basic ind.	0.15	0.88	0.01	0.02	0.17
3559	Rubber products n.e.c.	0.15	0.98	0.00	−0.03	0.25
3523	Soap and cleaning prep.	0.15	1.22	0.01	−0.02	0.09
3214	Carpets and rugs	0.15	0.92	0.01	0.59	0.10
3521	Paints, varnishes and lacquers	0.15	0.90	0.00	0.13	0.12
3813	Structural metal products	0.15	0.96	0.00	0.45	0.22
3842	Railroad equipment	0.15	0.82	0.01	0.18	0.19
3540	Misc. prod. of petroleum	0.15	0.69	0.01	0.12	0.09
3692	Cement, lime and plaster	0.15	1.06	0.00	0.27	0.18
3211	Textiles spinning and weaving	0.16	1.01	0.00	0.00	0.20

Table 1 (*continued*)

ISIC	Description	Inventories over sales (1)	Cash conversion cycle (2)	Short-term debt over sales (3)	External dependence (4)	Labor costs over sales (5)
3522	Drugs and medicines	0.16	1.12	0.00	1.47	0.18
3320	Furniture and fixtures	0.16	1.07	0.01	0.19	0.26
3710	Iron and steel basic ind.	0.16	0.90	0.00	0.00	0.24
3118	Sugar factories and ref.	0.16	0.88	0.01	−0.21	0.09
3620	Glass and glass prod.	0.16	0.96	0.00	0.26	0.24
3841	Ship building and repair	0.17	0.80	0.02	0.46	0.30
3812	Metal furniture and fixtures	0.17	1.12	0.00	0.07	0.23
3610	Pottery, china and earthenware	0.17	1.23	0.00	−0.21	0.35
3219	Textiles n.e.c.	0.18	0.93	0.02	0.05	0.16
3833	Electrical appliances	0.18	1.25	0.01	0.29	0.17
3819	Fabricated metalprods.	0.18	1.06	0.01	0.30	0.23
3821	Engines and turbines	0.19	1.27	0.02	0.23	0.24
3691	Structural clay prods	0.19	1.11	0.00	0.22	0.27
3212	Textile goods exc. apparel	0.19	1.13	0.02	0.01	0.23
3131	Distilling spirits	0.19	1.37	0.06	0.70	0.07
3220	Wearing apparel exc. footwear	0.20	1.23	0.02	0.09	0.24
3825	Office and computing mach.	0.20	1.51	0.01	1.07	0.23
3909	Industries n.e.c.	0.20	1.41	0.02	0.44	0.23
3811	Cutlery and hand tools	0.20	1.39	0.00	−0.09	0.25
3113	Fruits and veg. canning	0.20	0.86	0.02	0.08	0.11
3831	Elect. ind. machinery	0.20	1.54	0.01	0.27	0.24
3822	Agric. mach. and equip.	0.20	1.45	0.03	0.33	0.16
3903	Sport and athletic goods	0.21	1.29	0.05	0.16	0.19
3832	Radio, TV. and comm. eqp.	0.21	1.46	0.01	0.93	0.27
3839	Elect. app. and supp. n.e.c.	0.21	1.41	0.00	0.42	0.21
3829	Machinery and eqp. n.e.c.	0.21	1.32	0.02	0.30	0.25
3851	Scientific equipment	0.21	1.67	0.00	1.05	0.27
3240	Footwear	0.22	1.33	0.01	−0.22	0.23
3845	Aircraft	0.22	1.35	0.01	0.28	0.31
3823	Metal and wood wkg. mach.	0.23	1.51	0.01	0.17	0.30
3140	Tobacco manufactures	0.24	1.40	0.02	−0.27	0.07
3852	Photo. and optical goods	0.25	1.71	0.02	0.72	0.30
3824	Special indus. mach. and eqp.	0.25	1.53	0.01	0.37	0.26
3853	Watches and clocks	0.26	1.42	0.03	0.79	0.20
3902	Musical instruments	0.28	1.89	0.01	0.59	0.28
3233	Leather products	0.29	1.57	0.04	−1.53	0.25
3901	Jewelry	0.30	1.98	0.07	0.79	0.16
Correlations		1	0.93**	0.43**	0.20	0.46**

external dependence. Notice that although the correlations are positive and significant, they are below 0.5 (except for the correlation with the CCC, which is computed using the ratio of inventories to the cost of goods sold). This is important because some of these measures could be also capturing other industry characteristics besides liquidity needs, such as labor intensity (for the labor-cost-to-sales ratio). Finally, although capturing a similar mechanism, the Rajan and Zingales measure of external dependence is more closely associated with a firm's long-run rather than short-run dependence on external funds, so it

should have less explanatory power than the inventory-to-sales ratio. The results below will show that this is indeed the case.

As discussed in the previous section, the measures of liquidity needs built using U.S. data can be extrapolated to industries in other countries under the assumption that they are determined by technological factors that are industry specific. The evidence presented in Table 2 provides some empirical support for this assumption. The table shows the results of several regressions between the alternative measures of liquidity needs discussed above and similar measures built using data from non-U.S. firms contained in the Worldscope database. For each country with firms included in the Worldscope database, the industry-level measures of liquidity needs were built in the same manner as the corresponding U.S. measures described above, except that the time period used is 1993–2003 because Worldscope does not contain data before 1990 and only limited data for the years 1991 and 1992. The summary statistic for each industry was obtained by running a regression of these country-industry measures against a set of country and industry fixed effects, and taking the coefficient obtained for the corresponding industry. The results reported in Table 2 show that all these measures are positively correlated with the corresponding U.S. measures, and, except for the ratio of short-term debt to sales, the coefficients are highly significant. Similar results are obtained by directly running a regression of the country-industry measures of liquidity needs from Worldscope against a set of country fixed effects and the corresponding industry-level U.S. measures, or by using

Table 2
Comparing industry measures of liquidity needs: Worldscope vs. Compustat

All regressions were estimated by OLS. The columns represent different dependent variables. Each observation corresponds to one four-digit ISIC industry. The inventory-to-sales ratio of Worldscope firms in each four-digit ISIC industry (Column 1) corresponds to the industry fixed effects from a regression of the median inventory-to-sales ratio of each industry in each country on a set of country and industry fixed effects. The regressions excluded data from the U.S. to avoid spurious correlation with the Compustat ratios used as independent variables. The Worldscope industry values for the cash conversion cycle (Column 2) and the ratio of short-term debt to sales (Columns 3 and 4) were obtained in a similar manner. **: Significant at 1% level. *: significant at 5% level.

	Dependent variable			
	Inventory to sales Worldscope (93–03) (1)	Cash conversion cycle Worldscope (93–03) (2)	Short-term debt to sales Worldscope (93–03) (3)	Short-term debt to sales Worldscope (93–03) (4)
Inventory to sales (Compustat 80–89)	0.831** (0.094)	– –	– –	– –
Cash conversion cycle (Compustat 80–89)	– –	0.738** (0.094)	– –	– –
Short-term debt to sales (Compustat 80–89)	– –	– –	0.024 (0.036)	– –
Inventory to sales (Worldscope 93–03)	– –	– –	– –	0.232** (0.078)
Observations	87	87	87	89

the U.S. measures built using data from the period 1990–1999. The strength of the correlation between the preferred measure of liquidity needs (the inventory-to-sales ratio) in Worldscope countries and the U.S. is shown in Fig. 1. The lack of significance for the ratio of short-term debt to sales is not surprising because, among the alternative measures, it is the one that is less related to technological characteristics and more related to the particular characteristics of the financial system in which a firm operates. Nevertheless, Column 4 shows that, as was the case in the U.S., the ratio of short-term debt to sales in Worldscope countries is positively and significantly correlated with the level of inventory to sales.

4.2. Volatility

The volatility of an industry in a given country was determined using data from the United Nations Industrial Development Organization (2000), *Industrial Statistics Database* (UNIDO). This database contains information on nominal value added, employment, number of establishments, wages and salaries, gross output, and gross capital formation for 114 countries and 81 four-digit ISIC industries during 1980–1998. However, the real scope of the data is considerably smaller because there is plenty of missing

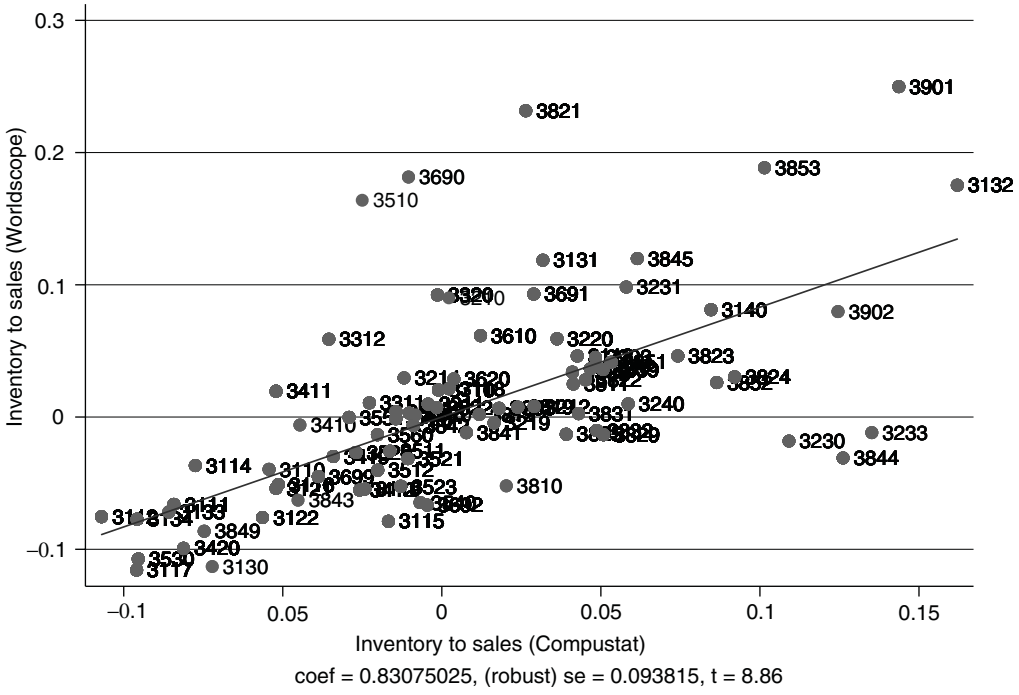

Fig. 1. Inventory over sales: Worldscope vs. Compustat: the figure shows the relation between the industry-level measures of inventory over sales built using data from firms included in the Worldscope database, excluding U.S. firms (*y*-axis), and data from U.S. firms from the Compustat database, which are the benchmark measures of liquidity needs (*x*-axis). The labels in the figure correspond to the four-digit ISIC code of each industry. The line represents the OLS fitted linear relation between the variables.

information. In addition, several countries do not report data for every four-digit ISIC industry, but only for groups of them. Since the grouping varies from country to country, these data are not comparable and have to be dropped. Data in other countries presented some inconsistencies across periods and were also dropped. The final sample used in the analysis is an unbalanced panel of 47 countries (plus the U.S., which is the benchmark country) with data on at least ten of 70 four-digit ISIC industries. The average number of industries per country is 51. According to the income classification of the World Bank, the sample includes 19 high-income countries, 20 middle-income countries, and eight low-income countries. (Many Gulf States (including Kuwait), and some East Asian Countries (including Singapore), are considered high-income countries.) The list of countries, along with the measures of financial development described in the next section, the number of industries observed in each country, and the time period with available data, is presented in Table 3.

Table 3
Sample of countries

Sample corresponds to those countries included in the UNIDO 2000 database (four-digit ISIC) that had at least five observations of the growth in real value added in at least ten industries. Column 1 presents the average level of private credit by domestic banks and other financial institutions as a fraction of GDP between 1980 and 1995; Column 2 shows the quality of accounting standards in 1990 built by CIFAR and extracted from La Porta et al. (1998). Countries with a larger index have better-quality accounting standards. Column 3 presents the average level of stock market capitalization as fraction of GDP (extracted from Beck et al., 2001a). Column 4 shows the log real GDP per capita in PPP. Column 5 reports the number of sectors at four-digit ISIC used in the estimation. Finally, Columns 6 and 7 show the first and last year of data available for each country, respectively.

	Private credit (1)	Accounting standards (2)	Stock. capitalization (3)	GDP pc. (PPP log) (4)	Number of sectors (5)	Initial year (6)	Final year (7)
Australia	0.81	0.75	0.41	9.44	60	1981	1992
Austria	0.87	0.54	0.07	9.26	48	1981	1998
Bangladesh	0.16	–	0.01	6.99	56	1981	1992
Cameroon	0.23	–	–	7.09	10	1981	1997
Canada	0.77	0.74	0.45	9.56	60	1981	1998
Chile	0.50	0.52	0.43	8.27	65	1981	1998
Colombia	0.27	0.50	0.06	7.99	69	1981	1998
Costa Rica	0.17	–	0.05	8.22	56	1981	1997
Ivory Coast	0.35	–	0.04	7.49	13	1991	1997
Cyprus	0.77	–	0.18	8.57	45	1981	1998
Ecuador	0.19	–	0.10	8.08	64	1981	1994
Egypt	0.28	0.24	0.05	7.41	67	1981	1995
Fiji	0.30	–	0.02	8.19	25	1981	1994
Finland	0.67	0.77	0.18	9.29	67	1981	1995
France	0.91	0.69	0.19	9.37	15	1981	1995
Germany	0.92	0.62	0.17	9.39	54	1981	1993
Ghana	0.03	–	0.13	6.88	51	1981	1994
Greece	0.40	0.55	0.08	8.68	42	1984	1995
Honduras	0.29	–	0.08	7.33	55	1982	1996
Hong Kong	1.36	0.69	1.28	9.07	54	1991	1996
Iceland	0.39	–	0.09	9.36	28	1981	1995
India	0.27	0.57	0.12	6.78	70	1981	1995

Table 3 (*continued*)

	Private credit (1)	Accounting standards (2)	Stock. capitalization (3)	GDP pc. (PPP log) (4)	Number of sectors (5)	Initial year (6)	Final year (7)
Indonesia	0.26	–	0.05	7.16	69	1981	1997
Jordan	0.62	–	0.52	8.13	45	1981	1996
Korea	0.81	0.62	0.24	8.04	70	1981	1997
Kuwait	–	–	0.51	–	35	1981	1997
Malaysia	0.80	0.76	1.05	8.24	64	1985	1996
Malta	0.60	–	–	8.41	34	1981	1993
Mauritius	0.29	–	0.23	8.29	44	1981	1996
Mexico	0.18	0.60	0.15	8.71	52	1985	1995
Netherlands	1.28	0.64	0.39	9.33	17	1981	1995
Norway	0.89	0.74	0.15	9.40	64	1981	1995
Panama	0.51	–	0.06	8.13	36	1981	1994
Peru	0.10	0.38	0.07	7.96	69	1981	1992
Philippines	0.29	0.65	0.20	7.54	63	1981	1997
Portugal	0.63	0.36	0.08	8.51	69	1982	1995
Singapore	0.95	0.78	1.24	8.86	54	1981	1995
Spain	0.72	0.64	0.17	8.91	70	1981	1995
Sri Lanka	0.19	–	0.13	7.40	62	1981	1995
Sweden	1.09	0.83	0.37	9.43	64	1981	1994
Trinidad and Tobago	0.50	–	0.11	9.33	34	1981	1995
Tunisia	0.56	–	0.08	–	15	1981	1997
Turkey	0.14	0.51	0.06	7.96	67	1982	1997
United Kingdom	0.74	0.78	0.76	9.23	70	1981	1995
United States	1.31	0.71	0.57	9.64	–	1981	1998
Uruguay	0.31	0.31	0.01	8.54	57	1981	1995
Venezuela	0.39	0.40	0.08	8.91	67	1981	1996
Zimbabwe	0.22	–	0.13	7.10	25	1981	1995
Correlations							
Private credit	1.00	0.63	0.63	0.73	−0.06	–	–
Accounting standards		1.00	0.58	0.54	−0.16	–	–
Stock capitalization			1.00	0.33	0.10	–	–

The industry-level data were used to build several measures of volatility. The main measure used in the paper is the *standard deviation of the growth of real value added*, which equally weights upturns and downturns, so it captures the degree of overall volatility of an industry. The median absolute deviation of the growth of real value added and the standard deviation of the growth of real output were also built to check that the results are not driven by outliers or by the specific method used to measure value added across countries. Additional measures were also built to explore the effect of financial development during downturns. The first of these measures is the *worst output performance*, which corresponds to the minimum growth rate observed for a country-industry during the period of analysis, and the second measure is the *frequency of downturns*, which corresponds to the fraction of the time that real value added contracts by more that 20% (which is the 25th percentile of industry growth rates).

The growth rate of real value added was computed using data on nominal value added from UNIDO and one of the following country level deflators: the Producer Price Index

from the International Monetary Fund (2002) *International Financial Statistics* (IFS), the Index of Industrial Production, also from IFS, or the ratio of nominal value added to real value added in manufactures from the World Bank (2002b) *World Development Indicators*. Following Rajan and Zingales (1998), the first was used as the main deflator, the second was used for high-inflation countries (Peru is the only case of hyper-inflation), and the last in cases where none of the other deflators was available. The nominal industry-level data were also deflated using three-digit-ISIC industry-specific deflators built using data from industrial production indexes and nominal output from the three-digit version of UNIDO. This addresses concerns raised by using a common deflator for all industries in a country. However, this procedure has two disadvantages: (i) it reduces the number of observations; and (ii) the data on industrial production indexes are of low quality. Nevertheless, the results obtained under both deflation procedures are very similar, so this paper reports mainly the results obtained with the more accepted country-level deflators. The results obtained with the three-digit level deflators are reported for the benchmark regression as a robustness check.

4.3. Financial development

Three measures of financial development are used throughout the paper. The main measure is the average *private credit as a fraction of GDP* observed during 1980–1995,[3] which captures the development of financial intermediaries. This measure includes the credit by banks and other financial institutions but excludes the credit allocated by the Central Bank. The reason for excluding the latter is that it is likely to be determined by political rather than economic considerations. Data for this measure were obtained from Beck et al. (2000).

The two other measures of financial development are the quality of *accounting standards* and the *stock market capitalization*. These measures are considered to explore the different channels by which financial development affects sector volatility, especially the role of information and market structure (banks versus markets), and to check the robustness of the results to the use of measures that capture different dimensions of financial development.

The quality of *accounting standards*, obtained from La Porta et al. (1998), captures the quality of the information available to outside investors, and it is related to the characteristics of the contracting environment in which firms develop. This measure should be relevant for more than just market-based systems because, even in a bank-based system, the monitoring cost incurred by a bank should decrease with the quality of the information typically produced by a firm.

Finally, the *stock market capitalization*, obtained from Beck et al. (2001a), is a measure of the size of a country's equity markets with respect to GDP. This measure, which has been used previously to investigate the effect of financial development on growth, has the advantage of being comparable to the measure of private credit (both measure size as a

[3]I use the average value instead of the initial one because the sample of countries is larger in the former case and the averaging reduces the noise that is present when using only the value at the beginning of the period. The main concern is that using ex post values may increase the endogeneity problems. However, standard tests cannot reject the hypothesis of exogeneity. In addition, the results obtained when using the initial value are almost identical to those obtained using the average.

fraction of GDP). Its main disadvantage is that it does not contain information about the activity level of stock markets. The results are not significantly affected when a measure of activity (value traded) rather than stock market capitalization is used.

As previously mentioned, any available measure of financial development is likely to contain measurement error. There are at least two reasons for this. First, it is difficult to capture the different aspects of financial development in a single measure. Second, there are idiosyncratic differences across countries in the availability of unobservable sources of working capital (such as trade credit or ownership structures). To address this problem, the different measures of financial development will be instrumented using dummy variables representing a country's legal origin (English, French, German, or Scandinavian). These instruments, which are standard in the law and finance literature, were obtained from La Porta et al. (1998) and complemented with data from the World Bank (2002a) *Global Development Network Growth Database*.

Of course, the ability of the instrumental variable procedure to solve the problem of measurement error and the possible presence of some degree of reverse causality depends crucially on the validity of the exclusion restrictions associated with the instruments. These restrictions require that the instruments, in this case the legal origin of a country, affect the volatility of sectors with high liquidity needs only through their impact on financial development. Although this is a reasonable assumption, I will also use standard statistical tests (Hansen-Sargan) to assess its validity, and in the robustness section I will examine this hypothesis in light of the possibility that the legal origin of a country could be related to the level of protection of property rights which could affect more importantly industries that are more institutionally dependent. As will be shown later, the results are robust to this alternative explanation. However, it is important to notice that the instrumental variable procedure does not permit ruling out the possibility that general institutions, like property rights, have an effect on volatility through their impact on financial development, as suggested by the findings of Acemoglu and Johnson (2004).

The list of countries used in the analysis and the value of the different measures of financial development for each one of them are summarized in Table 3. The measures of accounting standards and stock market capitalization are only available for a subset of the countries with information on private credit. The correlation between the measures, reported at the bottom of the table, is positive but not exceptionally high.

5. Results

5.1. Financial development and volatility

Table 4 reports the results for the standard deviation of the growth of real value added, which is the main measure of volatility. Two different specifications of Eq. (1) are presented. The first specification includes only the interaction between liquidity needs and financial development (plus the corresponding set of country and industry fixed effects). The second specification adds two controls: the initial share of a sector in a country's manufacturing value added, and the (log) of the initial number of firms. The initial share is akin to the initial income in cross-country regressions, and is intended to capture the possibility that a more developed or mature sector is systematically less volatile. The initial number of firms is included to control for a "law of large numbers" effect: in the presence of similar firm-specific shocks across countries, sector volatility will be lower the larger is

Table 4
Financial development and sector volatility (Standard Deviation)

The dependent variable is the standard deviation of real value added growth during 1981–1998 for each four-digit ISIC industry in each country. The regressions included country and industry fixed effects (not reported). The interaction term *Liquidity needs* × *private credit* is the product of those two variables. *Liquidity needs* is the median ratio of total inventories over annual sales for U.S. corporate firms in each four-digit industry between 1980–1989. *Private credit* is the average ratio of private credit by private banks and other financial institutions to GDP during 1980–1995. The section Differential volatility reports how volatile is an industry at the 75th percentile level of liquidity needs with respect to an industry at the 25th percentile level when it is located in a country at the 75th percentile of financial development rather than in one at the 25th percentile, both in percentage points and as a fraction of the interquartile range of volatility. Columns 1 and 2 report OLS regressions. Columns 3 and 4 report the 2SLS results obtained when the measure of financial development is instrumented using a country's legal origin. Columns 5 and 6 report the 2SLS results obtained when the measure of liquidity needs is instrumented using the ratio of inventory to sales observed during the 1970s and financial development is instrumented using a country's legal origin. Heteroskedasticity robust standard errors are reported in parentheses. **: Significant at 1% level. *: significant at 5% level.

	OLS		2SLS (I)		2SLS (II)	
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Interaction (liquidity needs × private credit)	−0.679** (0.146)	−0.492** (0.144)	−1.375** (0.230)	−0.984** (0.219)	−1.548** (0.297)	−1.171** (0.284)
Industry's initial share of total manufacturing VA	– –	−0.553** (0.132)	– –	−0.528** (0.127)	– –	−0.516** (0.126)
Industry's initial number of firms (log)	– –	−0.027** (0.003)	– –	−0.027** (0.003)	– –	−0.027** (0.003)
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Overid test (Hansen-Sargan)						
χ^2			1.46	4.27	1.00	0.44
P-value			0.48	0.12	0.61	0.80
Differential volatility						
Percentage points	2.67	1.94	5.41	3.87	6.10	4.61
Fraction of IQRV	33.42	24.22	67.68	48.43	76.19	57.64
Observations	2355	2276	2340	2262	2311	2233

the number of firms.[4] Three different sets of parameters are reported for each specification. The OLS coefficients are reported in Columns 1 and 2. Columns 3 and 4 present the 2SLS coefficients obtained when financial development is instrumented by the legal origin of the

[4]Two other possible controls were attempted: (i) the average growth rate of the industry, to capture the possibility that a fast-growing industry is relatively less volatile (also to capture any potential growth-volatility link; see Ramey and Ramey, 1995); and (ii) the interaction between an industry's intrinsic volatility and a country's aggregate volatility, to control for the possibility that some industries are more volatile than the average in every country (this could be relevant because of the relation between liquidity needs and durable goods industries, which also tend to be relatively more volatile than non-durable goods industries). However, these controls were not significant in any specification. Similar results to those reported in Table 4 are obtained when each variable is separately added to the base specification.

country. Finally, Columns 5 and 6 display the 2SLS coefficients obtained when both the financial development and the liquidity needs measures are instrumented. The instrument used for the measure of liquidity needs is the inventory-to-sales ratio measured in the '70s.[5]

The results presented in Table 4 are consistent with the hypothesis that financial development significantly reduces the relative volatility of sectors with high liquidity needs. The first row of the table shows that, regardless of the set of controls or the estimation technique, the coefficient estimated for the interaction between financial development and liquidity needs (γ in Eq. (1)) is negative and statistically significant. Of course, the statistical significance does not guarantee that the magnitudes of the coefficients are economically meaningful, but the results reported in the *Differential volatility* section of the table show that this is also the case. These results correspond to the estimated effect of an increase in financial development from the 25th to the 75th percentile level on the difference in volatility between the industries located at the 25th and 75th percentile levels of liquidity needs. In terms of actual countries and industries, this corresponds approximately to the effect of moving from the level of financial development of Egypt to the level of Spain on the difference in volatility between the electric industrial machinery industry (ISIC 3831) and the paper boxes industry (ISIC 3412). According to the results reported at the bottom of Column 3, the difference in standard deviation between these two industries would fall by 5.4 percentage points as a result of the increase in financial development, which represents about 68% of the interquartile range of volatility (IQRV). The IQRV is calculated computing the average standard deviation of each industry across countries, ranking the industries according to this average from more volatile to less volatile, and then measuring the difference in this average between the industry ranked at the 75th and 25th percentile level. Similar calculations reported for the rest of the columns confirm that the estimated coefficients are indeed economically significant.

Three additional aspects of the regressions reported in Table 4 are worth discussing. First, the point estimates are smaller in the specifications including additional controls, but not significantly so. The coefficients obtained for the different control variables, which are very similar across columns, show that sectors with a larger initial share of manufacturing value added or a larger initial number of firms are consequently less volatile. Second, the point estimates of γ obtained by 2SLS are larger in absolute value than those obtained by OLS. This finding is consistent with the presence of an attenuation bias that, as previously discussed, is probably the result of using imperfect measures of financial development and liquidity needs. Third, the results of the Hansen-Sargan overidentification test show that the null hypothesis of correct specification (exogeneity) cannot be rejected at standard confidence levels in any of the 2SLS regressions. Nevertheless, in what follows I will use the results obtained instrumenting only the measure of financial development as a benchmark (2SLS (I)) for two reasons: (i) the exogeneity of the instrument used for liquidity needs, which relies on the independence of the measurement errors between the two alternative measures, is less clear on theoretical grounds than the exogeneity of the instruments used for financial development; and (ii) these coefficients can be considered as an intermediate "compromise" between the OLS and the other 2SLS coefficients (2SLS (II)).

[5]Instrumenting one noisy measure of a variable by a different measure is standard in the literature. The assumption required for consistency is that the measurement errors of both variables are independent. The criteria used to select the ratio of inventory to sales in the 1970s as the instrument was the Shea's partial R^2.

5.2. Financial development and downturns

Table 5 presents the results obtained for the *worst output performance* (minimum growth rate of real value added observed in the period) in Panel A, and the *frequency of large downturns* (fraction of the observations in which real value added falls by more than 20%)

Table 5
Financial development and downturns

In Panel A the dependent variable is the minimum growth rate of real value added over the period 1981–1998 for each four-digit ISIC industry in each country (*worst output performance*). In Panel B, it is the fraction of years with a decline in real value added larger than 20% for each four-digit ISIC industry in each country during 1981–1998 (*frequency of downturns*). The interaction term *liquidity needs* × *private credit* denotes the product of those two variables. *Liquidity needs* is the ratio of total inventories over annual sales for U.S. corporate firms in each four-digit ISIC industry between 1980 and 1989. *Private credit* is the average ratio of private credit by private banks and other financial institutions to GDP during 1980–1995. The regressions include country and industry fixed effects (not reported). The section Differential volatility reports how volatile is an industry at the 75th percentile level of liquidity needs with respect to an industry at the 25th percentile level when it is located in a country at the 75th percentile of financial development rather than in one at the 25th percentile, both in percentage points and as a fraction of the interquartile range of the corresponding dependent variable. Columns 1, and 2 report OLS regressions. Columns 3, and 4 report the 2SLS results obtained when the measure of financial development is instrumented using a country's legal origin. Columns 5 and 6 report the 2SLS results obtained when the measure of liquidity needs is instrumented using the ratio of inventory to sales observed during the 1970s and financial development is instrumented using a country's legal origin. Heteroskedasticity-robust standard errors are reported in parentheses. **: Significant at 5% level; *: significant at 1% level.

Variables	OLS		2SLS (I)		2SLS (II)	
	(1)	(2)	(3)	(4)	(5)	(6)
A: *Dependent variable is the worst output performance* (*minimum growth rate 1981–1998*)						
Interaction (liquidity needs	0.692*	0.708**	1.876**	1.575**	1.825**	1.338**
× private credit)	(0.289)	(0.274)	(0.479)	(0.457)	(0.665)	(0.618)
Industry's initial share	–	0.884**	–	0.842**	–	0.841**
of total manufacturing VA	–	(0.241)	–	(0.232)	–	(0.233)
Industry's initial	–	0.034**	–	0.034**	–	0.035**
number of firms (log)	–	(0.006)	–	(0.006)	–	(0.006)
Industry's average growth	–	1.097**	–	1.123**	–	1.120**
of real VA (1981–1998)	–	(0.080)	–	(0.078)	–	(0.078)
Country and industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
P-value overid test		–	0.54	0.06	0.98	0.63
Differential volatility						
Percentage points	2.72	2.79	7.39	6.20	7.19	5.27
Fraction of IQRV	19.19	19.63	52.02	43.67	50.61	37.10
Observations	2355	2276	2340	2262	2311	2233
B: *Dependent variable is the frequency of downturns* (*fraction of growth rates* < -0.2 *1981* $-$ *1998*)						
Interaction (liquidity needs	−0.146	−0.239	−0.724**	−0.696**	−1.113**	−0.962**
× private credit)	(0.163)	(0.133)	(0.210)	(0.175)	(0.269)	(0.231)
Industry's initial share	–	−0.437**	–	−0.426**	–	−0.418**
of total manufacturing VA	–	(0.086)	–	(0.083)	–	(0.083)

Table 5 (*continued*)

Variables	OLS		2SLS (I)		2SLS (II)	
	(1)	(2)	(3)	(4)	(5)	(6)
Industry's initial number of firms (log)	–	−0.015**	–	−0.015**	–	−0.014**
	–	(0.002)	–	(0.002)	–	(0.002)
Industry's average growth of real VA (1981–1998)	–	−0.806**	–	−0.815**	–	−0.822**
	–	(0.040)	–	(0.039)	–	(0.039)
Country and industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
P-value overid test		–	0.89	0.15	0.69	0.48
Differential volatility						
Percentage points	0.57	0.94	2.85	2.74	4.38	3.79
Fraction of IQRV	9.27	15.18	45.98	44.20	70.68	61.09
Observations	2355	2276	2340	2262	2311	2233

in Panel B. The specifications and estimation methods are the same as discussed in Table 4, except that the average growth rate is also included among the additional controls.

The results show that financial development improves the worst output performance, and reduces the frequency of large downturns, comparatively more in sectors with high liquidity needs. These sectors seem to experience relatively larger and more frequent downturns in countries with low financial development. As is shown at the bottom of each panel (*Differential volatility* sections) both effects are economically significant. Using the parameters reported in Column 3, an increase in financial development equivalent to moving from the level of financial development of Egypt to the level of Spain would reduce the difference in the minimum growth rate between the electric machinery and paper boxes industries by 7.4 percentage points (52% of the interquartile range of minimum growth rates) and reduce the difference in the frequency of large downturns between these two industries by 2.9 percentage points (46% of the interquartile difference in frequency of downturns). These results are consistent with those reported in Table 4 and lend significant support to the idea that financial development has an important role during downturns, as stressed by some theoretical papers (e.g., Caballero and Krishnamurty, 2001).

6. Extensions

6.1. Estimating the effect of financial development on aggregate volatility

The results reported in Table 4 show that financial development reduces the relative volatility of industries with high liquidity needs. This finding is consistent with the hypothesis that financial development plays a causal role in the reduction of volatility, but the results do not tell us about the size of the effect. This magnitude can be estimated using the sector results and making a couple of additional assumptions in the following way. First, assuming that financial development does not affect output composition or the correlations across sectors, the effect of financial development on the standard deviation of

aggregate manufacturing volatility is given by

$$\frac{d\sigma}{dF} = \frac{1}{2\sigma}\sum_i \sum_j w_i w_j \rho_{ij}\left(\frac{d\sigma_i}{dF}\sigma_j + \sigma_i \frac{d\sigma_j}{dF}\right), \quad (2)$$

where σ is the standard deviation of aggregate manufacturing growth, w_i is the share of sector i on total manufacturing output, and ρ_{ij} is the correlation between sectors i and j.

Second, the coefficient γ estimates only the cross derivative of sector volatility with respect to financial development and liquidity needs ($\partial^2\sigma_i/\partial L_i \partial F$). It is therefore necessary to make an assumption about the total effect of financial development on the volatility of one particular sector to recover the total effect for the rest of them ($d\sigma_i/dF$) (this is equivalent to making an assumption about the unobserved level effect of financial development contained in the country fixed effect). A conservative assumption is that it has no impact on the volatility of the sector with the lowest liquidity needs.

Under these assumptions, and evaluating Eq. (2) at the average values of w_i and ρ_{ij} across countries (the specific formula used in this calculation is reported in Appendix B), an increase in financial development from the 25th to the 75th percentile would reduce the standard deviation of the growth of real manufacturing value added by 2.5 percentage points. This decline in volatility corresponds to 67% of the average difference in aggregate volatility among countries around those levels of financial development (3.8 percentage points). More conservative estimations can be obtained by using the 2SLS point estimator of γ minus one or two standard deviations, or by using the OLS coefficient. These estimations generate a decline in volatility of about 37% of the average difference in aggregate manufacturing volatility. Table 6 shows, for a set of financially underdeveloped countries, the estimated effect on aggregate manufacturing volatility of increasing their level of financial development from its current level up to the 75th percentile level (75% of GDP). It is clear that, for most of the countries, the effect is quantitatively important, with a mean and median decline in the standard deviation of aggregate manufacturing value added across countries of 1.9 and 1.6 percentage points, respectively.

It is also possible to use these simple calculations to obtain a rough estimate of the effect of financial development on the volatility of GDP per capita associated with its impact on sector volatilities, which can then be compared to existing estimations of the aggregate effect of financial development from the macro-finance literature (e.g., Denizer et al., 2002; Easterly et al., 2000). In the sample of countries and years considered in this paper, a one percentage point increase in the standard deviation of the growth of real manufacturing value added increases the standard deviation of the growth of real GDP per capita by about 0.4 percentage points. A very simple estimation of the effect of financial development on aggregate volatility, based on this ratio and the effect of financial development on the volatility of aggregate manufacturing value added computed above, suggests that an increase in the level of private credit corresponding to 50% of GDP would result in almost a one percentage point decline in the standard deviation of real-GDP-per-capita growth. (This estimation can be understood as the partial effect of financial development on the standard deviation of the growth of GDP per capita associated only with its effect on the standard deviation of the growth of real manufacturing value added.) This magnitude is about 80% and 50% of the effects estimated by Denizer et al. (2002) and Easterly et al. (2000) for a similar increase, respectively. Although this rough estimation cannot pretend to provide an accurate measure of the impact of financial development on

Table 6
Aggregate effect of financial development on developing countries' volatility

The results are reported only for those developing countries with data for at least 60 four-digit ISIC industries. Column 1 reports the level of financial development (average private credit as a fraction of GDP during 1980–1995). Column 2 shows the current aggregate volatility, measured as the standard deviation of the growth of real manufacturing value added during 1981–1998, and computed using each country's average productive structure and sector variance–covariance ($\sigma_k = \sqrt{\sum_i \sum_j \omega_i \omega_j \rho_{ij} \sigma_i \sigma_j}$). Column 3 shows the estimated volatility (standard deviation of the growth of total manufacturing value added) that would be observed if each of these countries changed its level of financial development from its current level to the 75th percentile level. The fall in volatility as a percentage of the initial level is reported in Column 4.

	Financial development (%GDP)	Current volatility (pct. points)	Volatility with high financial development (pct. points)	Decline in volatility (% curr. vol.)
Bangladesh	17	5	3	27
Chile	50	4	3	12
Colombia	27	6	5	26
Costa Rica	17	9	7	22
Ecuador	19	12	11	11
Egypt	28	7	6	14
Honduras	29	5	3	30
India	27	6	5	30
Indonesia	26	13	10	26
Peru	10	13	10	21
Philippines	29	13	11	20
Sri Lanka	19	10	6	39
Turkey	14	9	6	33
Uruguay	31	13	11	13
Venezuela	39	11	10	9

aggregate macroeconomic volatility, especially given the assumptions required to extrapolate from the sector results to the aggregate, these results confirm that the implied effects are of the right order of magnitude, and that the aggregate impact is likely to be economically significant.

Of course, the assumption that financial development does not affect the productive structure or the correlations across sectors can easily be challenged. For example, countries with underdeveloped financial systems might not develop industries that have high liquidity needs. Such an endogenous response would not invalidate the finding that financial development reduces the relative volatility of industries with high liquidity needs, but it would imply that the aggregate effect would be smaller than the one calculated above.

Regressions reported in Table 7 suggest that this mechanism is unlikely to be quantitatively important. These regressions present the results of estimating the following simple specification:

$$S_{i,k} = \eta_k + \chi_i + vL_i \mathrm{x} F_k + \mu_{i,k},$$

where $S_{i,k}$ is the average share of sector i in country k and η_k and χ_i are country- and industry-specific effects. The parameters were estimated by OLS (Column 1), and the two forms of 2SLS described for Table 4 (Columns 2 and 3). According to these results, financial development has a positive effect on the relative shares of sectors with high liquidity needs.

Table 7
Financial Development and Productive Structure

The dependent variable is the average share of total manufacturing value added during 1981–1998 for each four-digit ISIC industry in each country. The interaction term *liquidity needs* × *private credit* denotes the product of those two variables. *Liquidity Needs* is the ratio of total inventories over annual sales for U.S. corporate firms in each four-digit industry between 1980 and 1990. *Private credit* is the average ratio of private credit by private banks and other financial institutions to GDP during 1980–1995. The regressions include country and industry fixed effects (not reported). Column 1 reports the OLS coefficients. Column 2 shows the 2SLS coefficients obtained when the measure of financial development is instrumented using a country's legal origin. Column 3 presents the results obtained when the measure of liquidity needs is instrumented by the ratio of inventories to sales observed in the 1970s and financial development is instrumented using a country's legal origin. The errors are clustered by country to control for the inter-industry correlation resulting from the use of shares as a dependent variable. Heteroskedasticity and correlation robust standard errors are reported in parentheses. **: Significant at 5% level; *: significant at 1% level.

Variable	OLS	2SLS(I)	2SLS(II)
	(1)	(2)	(3)
Panel A: All industries			
Interaction (liquidity needs × private credit)	0.096** (0.029)	0.163** (0.051)	0.168** (0.057)
Country and industry fixed effects	Yes	Yes	Yes
Observations	2355	2340	2311
Panel B: No petroleum refineries			
Interaction (liquidity needs × private credit)	0.053 (0.033)	0.085 (0.051)	0.093 (0.056)
Country and industry fixed effects	Yes	Yes	Yes
Observations	2326	2311	2282

However, the significance and size of the parameter depends crucially on whether the petroleum refineries industry (ISIC 3530) is included in the sample, as is apparent by comparing the results in Panels A and B. In addition, the effect implied by the point estimates is quantitatively small. An increase in financial development from the 25th to the 75th percentile would increase the difference in shares between the industry at the 75th percentile and the industry at the 25th percentile of financial development by only 0.6 percentage points using the results of Panel A, and 0.3 percentage points using the results of Panel B.

In addition to the previous results, Fig. 2 shows that most of the observed differences in aggregate output variance across countries can be explained by the differences in their sector variances. Any effect of financial development on sector correlations or on the productive structure is thus likely to have a second-order impact on aggregate volatility. The leftmost panel of the figure (Panel A) plots the actual aggregate variances of a sample of countries (those with data on most of the industries) against the counterfactual aggregate variances computed by allowing only sector standard deviations to take their actual values across countries, while sector shares and correlations are kept at their cross-country average levels. In Panel B the counterfactual aggregate variance is computed allowing only the sector shares to vary across countries and industries, and in Panel C they

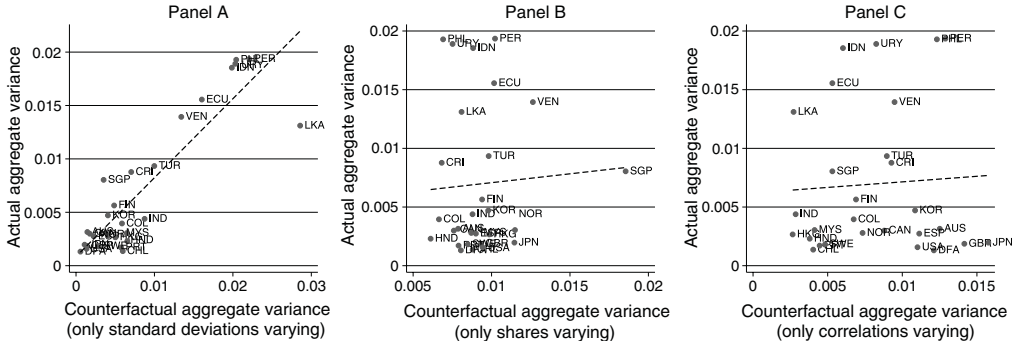

Fig. 2. Counterfactual aggregate variances: Panels A–C plot the variance of the growth of aggregate manufacturing value added (y-axis) against different counterfactual aggregate variances (x-axis). In Panel A the counterfactual aggregate variance is computed allowing only the sector standard deviations to take their actual values across countries and industries, while keeping the sector shares and the correlations across sectors at their cross-country averages. In Panel B it is the sector shares that are allowed to take their actual values while sector standard deviations and the correlations across sectors are kept at their cross-country means. Finally, in Panel C it is the correlations across sectors that are allowed to vary. The sample of countries includes those with data on at least 60 sectors, so that the aggregate variance computed from sector data is a good approximation of the true one.

are computed allowing the sector correlations to take their actual values. It is clear from the figure that the counterfactual variances computed when only the sector standard deviations vary across countries do an excellent job reproducing the actual differences in aggregate variances across countries, but the other two counterfactual variances are unable to replicate the actual data.

6.2. *Liquidity needs and growth*

As discussed in Section 2, the reason to expect that financial development will lead to a relatively greater reduction in the volatility of industries with high liquidity needs is that firms in these industries are more likely to require external funds to finance their working capital when affected by a negative shock. However, leaving aside a possible link between volatility and growth, this mechanism does not provide a basis to expect that firms with higher liquidity needs should also grow faster in countries with higher financial development. This limited role of the liquidity needs of an industry in the effect of financial development on that industry's volatility but not on its growth rate provides an interesting falsification exercise for the mechanism under consideration.

The results reported in Table 4 have already confirmed the link between liquidity needs, financial development, and volatility. The regressions reported in Table 8 show that, as expected, there is no robust link between liquidity needs, financial development, and growth. These regressions estimate the same specification of Eq. (1) but using the average growth rate during the period 1981–1998 as the dependent variable. The OLS results reported in Column 1 show a significant effect of the interaction term, but the coefficient has the wrong sign and its significance easily goes away with small modifications in the sample. If Hong Kong is excluded the coefficient is no longer significant at the 10% level. In fact, the changes in the sample resulting from the availability of the instrumental variables are the main reason why the 2SLS coefficients reported in Columns 2 and 3 are

Table 8
Liquidity needs, financial development, and growth

The dependent variable is the average rate of growth of real value added for each four-digit ISIC industry in each country during 1981–1998. Liquidity needs is the ratio of total inventories over annual sales for U.S. corporate firms in each industry between 1980 and 1989. Column 1 reports OLS regressions. Column 2 reports the 2SLS results obtained when the measure of financial development is instrumented using a country's legal origin. Column 3 reports the 2SLS results obtained when the measure of liquidity needs is instrumented using the ratio of inventory to sales observed during the 1970s and financial development is instrumented using a country's legal origin. Heteroskedasticity-robust standard errors are reported in parentheses. **: Significant at 1% level; *: significant at 5% level.

	OLS (1)	2SLS (I) (2)	2SLS (II) (3)
Interaction (liquidity needs × private credit)	−0.220*	−0.168	0.008
	(0.095)	(0.152)	(0.189)
Industry's initial share of total manufacturing VA	−0.262**	−0.263**	−0.269**
	(0.072)	(0.071)	(0.072)
Country and industry fixed effects	Yes	Yes	Yes
P-value overid test	–	0.26	0.87
Observations	2355	2340	2311

not significant. When restricted to the samples used in the 2SLS regressions, the OLS coefficient is no longer statistically significant.

6.3. *Financial structure, information, and volatility*

The recent literature that studies the effect of financial structure (bank-based versus market-based financial systems) on economic growth (e.g., Levine, 2002; Beck et al., 2001b; Levine and Zervos, 1998) has found that while the provision of financial services increases growth, the manner in which those services are provided (i.e., the financial structure) is not important. The regressions reported in Table 9 show that this is not the case for the relation between financial development and volatility: the development of financial intermediaries seem to play a much more important role than the development of arm's-length markets.

The table reports the results of estimating the parameters of Eq. (1) with three different measures of a country's level of financial development: the development of financial intermediaries (measured by private credit), which is the measure used in the previous tables; the quality of accounting standards, which captures the quality of information routinely available to investors; and the stock market capitalization, which measures the development of arm's-length markets. These measures of financial development were standardized so the coefficients are comparable across columns.

The first three columns of the table show that the results obtained when each aspect of financial development is considered separately are qualitatively similar. The main coefficient is negative and statistically significant in the three regressions. In this sense, the results reported in Table 4 are robust to the use of different measures of financial development. However, the magnitude of the coefficient is significantly smaller when the

Table 9
Financial structure, information, and volatility

The dependent variable is the standard deviation of real value added growth during 1981–1998 for each four-digit ISIC industry in each country. The interaction terms correspond to the product of *Liquidity needs* and different measures of financial development (*Private credit*, *Accounting standards*, and *Stock capitalization*). *Liquidity needs* is the median ratio of total inventories over annual sales for U.S. corporate firms in each four-digit ISIC industry between 1980 and 1989. *Private credit* is the average ratio of private credit by private banks and other financial institutions to GDP during 1980–1995. *Accounting standards* is a measure of the quality of accounting standards in 1990 built by CIFAR. *Stock capitalization* is the mean ratio of the stock market capitalization to GDP during 1980–1995. The regressions included country and industry fixed effects (not reported). The measures of liquidity needs, private credit, accounting standards, and stock capitalization have been standardized to make the coefficients easily comparable across columns. In Columns 1–5 the sample varies across estimations. Columns 6 to 8 present the results obtained with a common sample. The results for accounting standards in the common sample are not reported because they are identical to the results in the variable sample. The parameters were estimated by 2SLS using a country's legal origin as the instrument for the different measures of financial development. Heteroskedasticity-robust standard errors reported in parentheses. **: Significant at 1% level; *: significant at 5% level.

	Variable sample (2SLS (I))					Common sample (2SLS (I))		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Interaction (liquidity needs × private credit)	−0.034** (0.006)	– –	– –	−0.030** (0.011)	−0.033** (0.005)	−0.028** (0.005)	−0.033** (0.006)	−0.023 (0.012)
Interaction (liquidity needs × accounting standards)	– –	−0.018** (0.004)	– –	0.001 (0.008)	– –	– –	– –	−0.009 (0.010)
Interaction (liquidity needs × stock capitalization)	– –	– –	−0.015** (0.006)	– –	−0.002 (0.006)	– –	0.006 (0.004)	0.008 (0.005)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
P-value overid test	0.48	0.01	0.00	0.11	0.27	0.28	0.36	–
Observations	2340	1588	2296	1588	2296	1588	1588	1588

measures of accounting standards or stock capitalization are used. Perhaps more interesting is the fact that, while in Columns 2 and 3 the Hansen-Sargan test rejects the hypothesis of exogeneity, the hypothesis cannot be rejected when the interaction with private credit is included. This suggests that the development of financial intermediaries is indeed the main channel by which financial development affects the relative volatility of sectors with high liquidity needs.[6] This conjecture gathers additional support from the

[6]From a purely mechanical point of view, the rejection of the correct specification hypothesis tells us that the exclusion restriction on the instruments is likely wrong. In the regression using accounting standards, for example, this means that legal origin has an effect on the relative volatility of sectors with high liquidity needs beyond its effect on accounting standards. This will be indeed the case if the effect of legal origin mainly operates through the development of financial intermediaries, and accounting standards are imperfectly correlated with the latter.

regressions reported in Columns 4 and 5. They show that the coefficients of the interactions of liquidity needs and the alternative measures of financial development become insignificant when the interaction of liquidity needs and private credit is included in the regressions. At the same time, the coefficient of this interaction remains similar to the one reported in Column 1 and the overidentification test cannot reject the null hypothesis of correct specification.

The second half of the table (Columns 6–8) shows that the previous conclusions are not driven by variations in the sample of countries for which each measure of financial development is available. These columns present the same regressions as Columns 1–5 but maintaining a common sample. Regressions considering accounting standards are not presented because it is the availability of accounting standards that determines the minimum common sample, so they are identical to Columns 2 and 4. Finally, Column 8 also shows that the coefficient of the interaction with private credit is largely unaffected by including simultaneously the three alternative measures in the regression.

In summary, the results reported in Table 9 not only demonstrate that the main conclusions of the paper are robust to the specific measure of financial development, but also that, among the different aspects of financial development, it is the development of financial intermediaries that is responsible for the reduction in relative volatility of sectors with high liquidity needs. This finding is consistent with the special role that financial intermediaries play in liquidity provision, especially in developing countries where markets for commercial paper are typically absent.

From a theoretical point of view, this finding is consistent with the Holmstrom and Tirole (1998) model, which shows that, even in absence of aggregate shocks, firms cannot adequately provide liquidity for themselves using only claims on each other's assets but instead require the presence of an intermediary. Somewhat surprisingly, these results also imply that the quality of accounting standards has no independent effect on volatility beyond its relation with the development of financial intermediaries.

6.4. *How is the reduction in volatility achieved?*

The previous results show that financial development reduces the relative volatility of sectors with high liquidity needs. This section goes one step further into determining how this reduction is achieved. In particular, financial development can reduce the volatility of the growth of real value added in three ways: (i) it can reduce the volatility of the growth of value added per firm by making the firm's production more stable; (ii) it can reduce the volatility of the growth in the number of firms by reducing the number of bankruptcies during crises; or (iii) it can reduce the covariance between the previous two variables, thus reducing the probability of a simultaneous decline or increase in the number of firms and output per firm. The regressions reported in Table 10 explore how financial development affects each one of these components of growth volatility. Note that in order to perform the decomposition, I need to use variances instead of standard deviations as dependent variables. Also, I report the results obtained with the sample in which all components of the variance decomposition are observed, so the results are not directly comparable to those in Table 4, but they are qualitatively similar (compare Column 1 with the results reported in Table 4). The reason to choose the standard deviation as the base measure of volatility is that it is in the same units as the growth rate, which makes more clear its economic interpretation. It is also a standard measure of volatility in the literature.

Table 10
Decomposing the fall in volatility

The dependent variables are the following: the variance of real value added growth during 1981–1998 (Column 1); the variance of the growth of real value added per firm during 1981–1998 (Column 2); the variance of the growth in the number of firms during 1981–1998 (Column 3); and the covariance between the growth of real value added per firm and the growth in the number of firms during 1981–1998 (Column 4), for each four-digit ISIC industry in each country. The interaction term *liquidity needs* × *private credit* denotes the product of those two variables. *Liquidity needs* is the median ratio of total inventories over annual sales for U.S. corporate firms in each four-digit ISIC industry between 1980 and 1989. *Private credit* is the average ratio of private credit by private banks and other financial institutions to GDP during 1980–1995. The regressions included country and industry fixed effects (not reported). All the coefficients are estimated by 2SLS using a country's legal origin to instrument for its level of financial development. The estimation is performed over the sample in which the different dependent variables are simultaneously available. Heteroskedasticity-robust standard errors reported in parentheses. **: Significant at 1% level; *: significant at 5% level.

	Variance of real value added growth	Variance of real VA per firm growth	Variance of number of firms growth	Covariance of real VA per firm and number of firms growth
	(1)	(2)	(3)	(4)
Interaction (liquidity needs × private credit)	−1.055** (0.177)	−1.111** (0.235)	−0.365** (0.096)	0.182* (0.077)
Country fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
P-value overid test	0.35	0.69	0.65	0.31
Observations	2212	2212	2212	2212

The results show that an increase in financial development reduces both the relative volatility of the growth of value added per firm (intensive margin) and the volatility of the growth in the number of firms (extensive margin), but increases the covariance between these two components. However, the effect on the volatility of the growth of value added per firm is considerably larger than the effect on the extensive margin or the covariance term. The evidence thus suggests that most of the effect of financial development on sector volatility comes from reducing fluctuations in the production of existing firms, rather than smoothing fluctuations in the number of firms. Interestingly, the positive effect on the covariance term suggests that financial development makes it more likely that value added per firm and the number of firms grow and decline together. This finding gives some support to the idea that financial development can make crises more serious, but this effect is clearly second order in comparison with the other two.

7. Robustness

7.1. Standard robustness checks

The main results of the paper are robust to a battery of tests. The regressions reported in Table 11 show that the results are not significantly affected by considering different measures of volatility (the median absolute deviation in Columns 1 and 2 and the standard

Table 11
Robustness (different measures of volatility)

The dependent variables are the following: the median absolute deviation of real value added growth during 1981–1998 (Columns 1 and 2), the standard deviation of real output growth during 1981–1998 (Columns 3 and 4), the standard deviation of real value added growth during 1981–1998 in the sample of countries with at least 50 industries (Columns 5 and 6), and the standard deviation of the real value added growth during 1981–1998 obtained using three-digit deflators instead of country level deflators (Columns 7 and 8). All of them are observed for each four-digit ISIC industry in each country. The interaction term *liquidity needs* × *private credit* is the product of those two variables. *Liquidity needs* is the median ratio of total inventories over annual sales between 1980–1989 for U.S. corporate firms in each four-digit ISIC industry. *Private credit* is the average ratio of private credit by private banks and other financial institutions to GDP during 1980–1995. All coefficients are estimated by 2SLS using a country's legal origin to instrument for its level of financial development. The section Differential volatility, at the bottom of the table, reports how volatile is an industry at the 75th percentile level of liquidity needs with respect to an industry at the 25th percentile level when it is located in a country at the 75th percentile of financial development rather than in one at the 25th percentile, both in percentage points and as a fraction of the interquartile range of the corresponding dependent variable. Heteroskedasticity-robust standard errors are reported in parentheses. **: Significant at 1% level. *: significant at 5% level.

Variables	Median absolute deviation real VA growth		Standard deviation real output growth		Standard deviation real VA growth (balanced)		Standard deviation real VA growth (3-dig. deflator)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Interaction (liquidity needs × private credit)	−0.753**	−0.440**	−1.211**	−0.818**	−1.209**	−0.823**	−1.333**	−0.965**
	(0.180)	(0.174)	(0.188)	(0.178)	(0.202)	(0.194)	(0.229)	(0.220)
Industry's initial share of total manufacturing VA	–	−0.286**	–	−0.491**	–	−0.535**	–	−0.619**
	–	(0.089)	–	(0.130)	–	(0.130)	–	(0.149)
Industry's initial number of firms (log)	–	−0.021**	–	−0.024**	–	−0.027**	–	−0.026**
	–	(0.003)	–	(0.003)	–	(0.003)	–	(0.003)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
P-value overid test	0.55	0.64	0.94	0.11	0.56	0.05	0.65	0.29
Differential volatility								
Percentage points	2.96	1.73	4.77	3.22	4.76	3.24	5.25	3.80
fraction of IQRV	54.91	34.65	50.73	34.26	52.89	36.01	58.32	42.22
Observations	2340	2262	2110	2035	1879	1818	2214	2137

deviation of real output growth in Columns 3 and 4), using a more balanced panel including only those countries with more than 50 sectors (Columns 5 and 6), and using deflators at the three-digit ISIC level of aggregation to compute the real value added data (Columns 7 and 8).

The robustness of the results to the time period is analyzed in Table 12. The different columns of the table show the results obtained for three different subperiods: 1985–1995,

Table 12
Robustness (different periods)

The interaction term *liquidity needs* × *private credit* denotes the product of those two variables. *Liquidity needs* is the ratio of total inventories over annual sales for U.S. corporate firms in each four-digit ISIC industry between 1980 and 1989. *Private credit* is the average ratio of private credit by private banks and other financial institutions to GDP during each corresponding period. Additional controls include each industry's share of total manufacturing value added and the (log) number of firms at the beginning of each period. All columns report the 2SLS results obtained when the measure of financial development is instrumented using a country's legal origin. Heteroskedasticity-robust standard errors are reported in parentheses. **: Significant at 1% level; *: significant at 5% level.

Variables	Standard deviation real VA growth (1985–1995)		Standard deviation real VA growth (1981–1989)		Standard deviation real VA growth (1990–1998)	
	(1)	(2)	(3)	(4)	(5)	(6)
Interaction (liquidity needs × private credit)	−0.770** (0.263)	−1.157** (0.273)	−1.912** (0.525)	−2.382** (0.533)	−0.805 (0.877)	−2.062* (0.879)
Additional controls	Yes	No	Yes	No	Yes	No
Country and industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
P-value overid test	0.08	0.41	0.63	0.09	0.72	0.62
Observations	1907	1923	1651	1728	1334	1354

1981–1989, and 1990–1998. Columns 1 and 2 display the results for the period 1985–1995 with and without controlling for the initial share of manufacturing value added and the number of firms of each industry, respectively. The reason to look at this period is twofold. First, this is the decade for which most of the countries had continuous data (see the last two columns of Table 3), which partly reduces the concerns about the impact of unequal time periods (unbalancedness) on the results. Second, it excludes the beginning of the 1980s which is the period of the debt crisis. Columns 3 through 6 show similar regressions for the periods 1981–1989 and 1990–1998, respectively, which correspond to a roughly equal split of the period with available data (1981–1998). The idea behind this exercise is to determine whether the decline in volatility observed in most high-income countries during the last two decades has any influence on the results. Admittedly, most existing studies date the break in volatility in OECD countries at the mid 1980s (see Stock and Watson, 2003, and references therein) but the limited data availability makes it impossible to use a more appropriate selection of subperiods. Nevertheless, to the extent that only the period 1981–1989 includes some years of the high-volatility regime, the contrast between the results for this period and the results obtained for the period 1990–1998 can still shed some light on the issue. As is apparent from the different columns of the table, the results are largely unaffected by the particular period used in the regressions, which suggests that neither the uneven time periods used for different countries nor the decline in aggregate volatility during the last two decades significantly affect the conclusions of the paper.

Regressions presented in Table 13 reveal that the results are also generally robust to the use of different measures of liquidity needs, although some idiosyncratic differences are observed. Column 1 reproduces the result obtained with the ratio of inventory to sales,

which is the preferred measure of liquidity needs. To facilitate the comparison all the interaction terms were put in the same scale. The regressions presented in Columns 2–5 show the results obtained using the following alternative measures of liquidity needs: the *cash conversion cycle* (Column 2), the ratio of *labor cost to sales* (Column 3), the ratio of *short-term debt to sales* (Column 4), and the Rajan and Zingales' measure of *external dependence* (Column 5). All the coefficients are negative and significant at the 1% level. The magnitudes are also similar. Columns 6 to 8 show that the results are also robust to the specific manner in which the main measure of liquidity needs is computed. Columns 6 and 7, which use the ratio of inventory to sales measured during the 1970s and 1990s, respectively, reveal that the results are not specific to the period chosen to build the main measure (although the coefficient is smaller when using data from the 1990s). This finding reduces concerns about the role of the declining trend in the ratio of inventory to sales observed in the U.S. Column 8, which presents the results obtained when data from Spanish firms (Spain is the country at the 75th percentile of financial development) are used to build the industry ratio of inventory to sales, shows that the choice of the benchmark country is also not crucial for the results; although smaller in magnitude (which can result from a higher level of measurement error), the coefficient has the right sign and is significant at the 10% level. Finally, Column 9 shows the results obtained when the different proxies for liquidity needs are considered together (the measure for the CCC is left outside to avoid problems of multicollinearity because of its high correlation with liquidity needs). Only the ratio of inventory to sales remains significant and of similar magnitude as when included alone. To the extent that, as argued above, the inventory-to-sales ratio is a better measure of the liquidity needs of an industry, this result supports the idea that the mechanism by which financial development affects volatility is by improving liquidity provision. This is consistent with the fact that the Rajan and Zingales measure of external dependence, which mainly captures the dependence of an industry on the financial sector for its process of capital accumulation, loses significance when considered simultaneously with a more direct proxy of liquidity needs. The robustness of this interpretation of the results against alternative explanations is discussed in detail in the next section.

Several additional robustness tests performed on the results are not reported for reasons of space but are available upon request. These tests show that the main results are not significantly affected by excluding the sectors with the highest and lowest liquidity needs, using robust techniques of estimation, considering explicitly the possibility of sample selection in the data, and considering potential differences between high- and low-income countries.

7.2. Testing alternative explanations

Many factors can affect the volatility of an industry besides the interaction between liquidity needs and financial development, and the results could be misleading if one of these omitted determinants of sector volatility were correlated with this interaction. As discussed in Section 3, the inclusion of country and industry fixed effects significantly reduces these concerns, but there are at least two remaining problems. First, the measure of liquidity needs could be correlated with a different source of dependence on the financial sector. Second, the measure of financial development could be capturing a completely different source of volatility. In the latter case, the results would be biased if the dependence of different industries on the source of volatility were correlated with their level of liquidity needs. The regressions reported in Table 14 rule out several of these possibilities.

Table 13
Robustness (different measures of liquidity needs)

The dependent variable is the standard deviation of real value added growth during 1981–1998 for each four-digit ISIC industry in each country. The interaction terms are the product of the two corresponding variables. The industry-specific variables are the following: (i) *Inventory to sales (80s)* is the median ratio of total inventories to annual sales between 1980 and 1989; (ii) *cash conversion cycle* is defined as the average age of inventories plus the average age of accounts receivable minus the average age of accounts payable during 1980–1989; (iii) *Labor cost* is the ratio of labor costs over sales during 1980–1989; (iv) *Short-term debt* is the median ratio of notes over sales during 1980–1989; (v) *External dependence* is the Rajan and Zingales (1998) measure of external dependence; (vi) *Inventory to sales (70s)* and (vii) *Inventory to sales (90s)* are analogous to *Inventory to sales (80s)* but are built using data from the periods 1970–1979 and 1990–1999, respectively. All the previous measures were built using balance sheet data for U.S. corporate firms in the same four-digit ISIC industry from Compustat, except for *Labor cost*, which was built using data from the NBER productivity database (Bartelsman et al., 2001). Finally, (viii) *Inventory to sales (Spain)* is similar to *Inventory to sales (80s)* but built using balance sheet data for Spanish firms in the same four-digit ISIC industry during 1980–1989 from the Amadeus database. *Private credit* is the average ratio of private credit by private banks and other financial institutions to GDP during the period 1980–1995. The coefficients are estimated by 2SLS using a country's legal origin as an instrument of its level of financial development. All variables are normalized to facilitate comparison across columns. Heteroskedasticity-robust standard errors are reported in parentheses. **: Significant at 1% level; *: significant at 5% level.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Interaction (inventory to	−0.034**	–	–	–	–	–	–	–	−0.026**
sales (80s) × private credit)	(0.006)	–	–	–	–	–	–	–	(0.008)
Interaction (cash conversion	–	−0.029**	–	–	–	–	–	–	–
cycle × private credit)	–	(0.005)	–	–	–	–	–	–	–
Interaction (labor costs	–	–	−0.021**	–	–	–	–	–	−0.011
× private credit)	–	–	(0.005)	–	–	–	–	–	(0.006)
Interaction (short-term	–	–	–	−0.020**	–	–	–	–	−0.001
debt × private credit)	–	–	–	(0.008)	–	–	–	–	(0.008)
Interaction (external	–	–	–	–	−0.032**	–	–	–	−0.016
dependence × private credit)	–	–	–	–	(0.012)	–	–	–	(0.012)

Interaction (inventory to sales (70s) × private credit)	–	–	–	–	–	−0.024**	–	–	–
	–	–	–	–	–	(0.005)	–	–	–
Interaction (inventory to sales (90s) × private credit)	–	–	–	–	–	–	−0.019**	–	–
	–	–	–	–	–	–	(0.005)	–	–
Interaction (inventory to sales (Spain) × private credit)	–	–	–	–	–	–	–	−0.007	–
	–	–	–	–	–	–	–	(0.004)	–
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
P-value overid test	0.48	0.52	0.09	0.74	0.98	0.52	0.72	0.68	0.41
Observations	2340	2340	2504	2340	2340	2268	2317	2596	2237

Table 14
Robustness (alternative explanations)

The dependent variable is the standard deviation of real value added growth during 1981–1998 for each four-digit ISIC industry in each country. All the regressions include country and industry fixed effects (not reported). Each interaction term is the product of the corresponding two variables. The industry-specific variables, which were built using U.S. data, are the following: (i) *Liquidity needs*, which is the median ratio of total inventories over annual sales during 1980–1989; (ii) *human capital*, which is the fraction of the total wage bill corresponding to workers with at least some college education (obtained from Autor et al., 1998); (iii) *technology use*, which is the intensity of use of computer technology in the U.S. (also from Autor et al., 1998); (iv) *capital intensity* is the average physical-capital to total-employment ratio during 1980–1997 (obtained from the NBER Productivity Database, Bartelsman et al., 2001); (v) *tangibility* is the median ratio of property, plant, and equipment to total assets across U.S. corporate firms in a given industry (from Compustat); (vi) *durable* is a dummy variable that takes the value one for durable industries; and (vii) *industry volatility* is the standard deviation of real value added growth. The country-specific measures are the following: (a) *Private credit*, which is the average ratio of private credit by private banks and other financial institutions to GDP during 1980–1995; (b) *Executive Constraints*, which is an index that measures the level of discretion of the executive power, obtained from the Polity IV database; and (c) *Initial GDP per capita*, which is the log of GDP per capita in PPP adjusted dollars in 1980. The coefficients are estimated by 2SLS using a country's legal origin as an instrument of its level of financial development, and using the degree of settler mortality in former colonies to instrument the constraints on the executive. Accordingly, in Column 10 the sample includes only countries that were colonized. Heteroskedasticity-robust standard errors are reported in parentheses. **: Significant at 1% level; *: significant at 5% level.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Interaction (liquidity needs × private credit)	−1.375** (0.230)	−1.401** (0.232)	−1.367** (0.236)	−1.157** (0.233)	−1.004** (0.290)	−1.309** (0.243)	−1.376** (0.239)	−1.106** (0.250)	−1.165** (0.446)	−1.855** (0.614)
Interaction (human capital × private credit)	– –	−0.194 (0.108)	– –	– –	– –	– –	– –	– –	– –	– –
Interaction (technology use × private credit)	– –	– –	−0.063 (0.105)	– –	– –	– –	– –	– –	– –	– –
Interaction (capital intensity × private credit)	– –	– –	– –	0.143 (0.080)	– –	– –	– –	– –	– –	– –

Interaction (tangibility × private credit)	–	–	–	–	0.265	–	–	–	–	–
	–	–	–	–	(0.148)	–	–	–	–	–
Interaction (industry volatility × private credit)	–	–	–	–	–	−0.510	–	–	–	–
	–	–	–	–	–	(0.377)	–	–	–	–
Interaction (industry volatility × initial GDP)	–	–	–	–	–	–	−0.031	–	–	–
	–	–	–	–	–	–	(0.178)	–	–	–
Interaction (durable good × private credit)	–	–	–	–	–	–	–	−0.064*	–	–
	–	–	–	–	–	–	–	(0.026)	–	–
Interaction (liquidity needs × initial GDP)	–	–	–	–	–	–	–	–	−0.117	–
	–	–	–	–	–	–	–	–	(0.212)	–
Interaction (human capital × executive constraints)	–	–	–	–	–	–	–	–	–	−0.038
	–	–	–	–	–	–	–	–	–	(0.031)
P-value overid test	0.48	0.83	0.55	0.63	0.48	0.24	0.13	0.83	0.33	–
Observations	2340	2311	2311	2340	2340	2340	2340	2340	2340	1313

Industries with high liquidity needs might be more human capital or technology intensive. The reason is that these characteristics are probably related to the complexity of the product. The complexity of the product is associated with the number of tasks that are required for its elaboration (see Kremer, 1993; Clague 1991a, b) and the number of tasks is likely to affect the working capital requirements. In addition, moral hazard and hold-up problems are probably more important in sectors that are more human capital or technology intensive (which we could call "soft industries") because of the non-appropriable nature of these assets. These industries might therefore be more dependent on the financial sector for reasons different from their liquidity needs. The opposite argument applies to industries with a higher proportion of tangible assets. The relation between liquidity needs and physical capital intensity could also be problematic for the interpretation of the results. Capital intensive industries might have large debt service payments if part of the initial investment is financed with debt, which could make them more dependent on a stable and developed financial system. Columns 2–5 in Table 14 show that, even though some of these characteristics can affect the vulnerability of an industry to financial underdevelopment, their consideration does not affect the sign of the main coefficient, its magnitude, or the conclusions of the paper.

A different explanation of the results is that they could be driven by a general effect of financial or economic development on sector volatility. This could happen if financial development had a proportional effect on sector volatility. If so, the effect would not be wiped out by the country fixed effect and could be wrongly captured by the main interaction. One way of controlling for this possibility is to add the interaction between financial or economic development and the volatility of an industry in a benchmark country to the main specification. This is done in Columns 6 and 7. Column 6 adds the interaction between the volatility of an industry in the U.S. and financial development, and Column 7 does the same for initial GDP. As in the previous cases the main conclusions of the paper are not affected. The coefficient for the interaction between industry volatility and financial development is negative and close to significant, so the results provide some support to the presence of a proportional effect of financial development.

Finally, the regressions presented in Columns 8–10 of Table 14 check the possibility that the measure of financial development could be capturing a completely different source of volatility. These regressions rule out two such possibilities. First, financial development is correlated with the level of aggregate volatility, so it may be capturing the heterogeneous effects of aggregate shocks across sectors. For example, liquidity needs are correlated with the durability of the good, and it has been documented that the consumption of durable goods tends to be more volatile than the consumption of nondurable goods (see, for example, Baxter, 1996). To control for this possibility, Column 8 adds to the main specification the interaction between a dummy for durable goods and financial development.

Second, financial development is related to the degree of institutional quality and stability. This could be problematic if industries with high liquidity needs are also more "institutional dependent," which is possible given the relation between liquidity needs and product complexity. Industries producing complex products are more likely to deal with a large number of suppliers, and the quality of their inputs and output is also probably more difficult to determine; all of this makes these industries more dependent on the quality of the overall institutional environment (e.g., the legal and contracting system). For the relation between product complexity and number of suppliers (and contracts), see Clague

(1991a, b) and Cowan and Neut (2002). To control for this possibility, Column 9 adds to the main specification the interaction of initial GDP per capita (a proxy for institutional development) and liquidity needs, while Column 10 considers the interaction of a different measure of institutional development, the extent of *constraints on the executive* (from the Polity IV dataset), with human capital intensity, which proxies for a sector's institutional dependence because of its correlation with the complexity of the product (see Kremer (1993)). The constraints on the executive has been used by Acemoglu et al. (2003) in a similar manner; I use the average of the measure in the years 1960, 1970, and 1980, instead of its value in 1980, to reduce the noise induced by considering a single year. This last regression also deals with the potential endogeneity and measurement error of the institutional development proxy by instrumenting the *constraints on the executive* with a measure of *settler's mortality* in countries that were former colonies (see Acemoglu et al., 2001, 2003, which provide a detailed discussion of the reasons to use this instrument).

The results reported in Columns 8–10 show that the explicit consideration of these two alternative explanations of the relation between sector volatility and financial development does not affect the main conclusions of the paper. Indeed, in most of the cases the coefficients are not statistically different from the benchmark coefficient reported in Column 1.

8. Conclusion

This paper investigates the effect of financial development on volatility. The evidence shows that financial underdevelopment significantly increases the relative volatility of sectors that typically require large amounts of liquid funds to operate. This finding, which is robust to the specific measures of financial development and liquidity needs (and to a battery of additional tests) provides indirect but strong support for the theory that the development of the financial system has a causal role in the reduction of macroeconomic volatility, which is most likely associated with its ability to provide liquidity during periods of distress.

The paper also provides estimates of the potential effect of financial development on aggregate volatility. Admittedly, these aggregate results have to be taken cautiously because of the lack of data on non-manufacturing sectors, and because of the possibility that financial development has additional effects on volatility through channels that are not mediated by sector liquidity needs. Nevertheless, to the extent that the methodology isolates an important mechanism by which financial development affects volatility, and given that the manufacturing sector is a relatively important component of aggregate output, the results suggest that the effect of financial development on aggregate volatility is quantitatively important.

Additional regressions reported in the paper explore two further aspects of the mechanism by which financial development affects sector volatility. First, the paper shows that financial development reduces the relative variance of sectors with high liquidity needs mainly by reducing the relative variance of growth in output per firm and only secondarily by reducing the variance of the number of firms. This suggests that the main role of financial development is to help existing firms stabilize output rather than to reduce the degree of turnover (although fluctuations in the number of firms are only a rough proxy of firm turnover). These regressions also provide evidence that financial development slightly increases the relative covariance between output-per-firm growth and the growth in the

number of firms in sectors with high liquidity needs. Such sectors would more likely experience a simultaneous increase in both measures in a more financially developed country. Second, the results also show that the development of financial intermediaries is much more important than the development of equity markets for the reduction of volatility. The quality of the accounting information provided by firms (as measured by the accounting standards) has no independent effect on sector volatility after controlling for the development of financial intermediaries. These results are consistent with the fact that the overdrafts provided by banks are a much more important source of short-term credit for firms than commercial paper, especially in developing countries, where markets for commercial paper are largely nonexistent.

These findings have implications for the aggregate relation between financial development and volatility that deserve further analysis. First, if the development of financial markets is more beneficial (in terms of reduced volatility) for some industries than for others, the industry structure of a country should be considered when assessing the short-term aggregate benefits of financial reform. Analogously, the cost of financial underdevelopment will be higher for countries that, because of comparative advantage or industrial policy, concentrate their activity in sectors with high liquidity needs. Second, a country's comparative advantage can be an important determinant of its level of financial development. If these advantages are in sectors that typically require an efficient financial market to operate, then it is more likely that the consensus to generate the necessary reforms to the financial markets will be achieved. A further revision of these implications is part of future research.

Appendix A. A stylized model of liquidity needs and volatility

Assume that the world lasts two periods ($t = 1, 2$). In the first period, a firm gets a random amount of cash θ and decides how much to invest in working capital to produce output in the next period according to $Y = (K^{\alpha} + \phi W^{\alpha})^{1/\alpha}$, where K is considered fixed in the period of analysis and $\alpha < 1$.

The firm faces a financial constraint in its investment decision: it cannot invest more than a multiple $\lambda > 1$ of its capital-adjusted cash flow $K\theta$. That is,

$$W \leqslant \lambda K\theta.$$

The parameter λ captures the development of financial markets and the financial constraint is proportional to the capital level as a normalization, which allows me to express everything in terms of the ratio of working capital to physical capital. In a more developed financial market, a firm can borrow more for a given level of assets. This is a standard reduced-form representation of financial constraints that can be obtained under different microeconomic settings. For example, a constraint like this can be easily derived from ex post moral hazard considerations (see Aghion et al., 2000). The gross market interest rate on borrowing and lending is R.

The problem of the firm at $t = 1$ is therefore

$$\begin{aligned} \max_{W} \quad & (K^{\alpha} + \phi W^{\alpha})^{1/\alpha} - R\,W, \\ \text{subject to} \quad & W \leqslant \lambda K\theta. \end{aligned}$$

When the financial constraint is not binding, W is given by

$$(K^{\alpha}+\phi W^{\alpha})^{(1-\alpha)/\alpha}\phi W^{\alpha-1}=R.$$

Rearranging to express everything in terms of the ratio of working capital to physical capital ($w=W/K$), we obtain

$$w^{*}=\left[\left(\frac{R}{\phi}\right)^{\alpha/(1-\alpha)}-\phi\right]^{-1/\alpha}. \tag{A.1}$$

The result also implies that, at the unconstrained optimum, the working-capital-to-sales ratio is given by

$$\frac{W}{Y}=\left(\frac{\phi}{R}\right)^{1/(1-\alpha)},$$

so the ratio is increasing in ϕ. Hence, ϕ parameterizes the liquidity needs of a firm. In a perfect capital market, a firm with a larger ϕ will have a larger working-capital-to-sales ratio. It also can be easily verified that the ratio of working capital to physical capital is increasing in ϕ.

On the other hand, when the financial constraint is binding, working capital investment is determined by the cash available to the firm:

$$\tilde{w}=\lambda\theta.$$

The ratio of working capital to physical capital is therefore given by

$$w=\min\left\{\left[\left(\frac{R}{\phi}\right)^{\alpha/(1-\alpha)}-\phi\right]^{-1/\alpha},\lambda\theta\right\}.$$

The solution of the firm's problem as a function of the cash shock θ is depicted in Fig. 3, where $\tilde{\theta}$, which depends on λ and ϕ, is the value of θ at which the financial constraint is no longer binding.

To simplify the exposition, I will assume that the cash flow θ can take only two values: $\bar{\theta}$, which happens with probability p and represents the good times, and $\underline{\theta}$, which represents the bad times and occurs with probability $(1-p)$. Of course, $\bar{\theta}>\underline{\theta}$. To illustrate the intuition, I will also assume that $\bar{\theta}$ and $\underline{\theta}$ represent "extreme" states of nature in the sense that, while in good times no firm is financially constrained, all of them are constrained in bad times. The results can easily be extended to a continuous distribution of values.

The ratios of working capital to physical capital of two firms (sectors) with different levels of liquidity needs, $\underline{\phi}$ and $\bar{\phi}$ ($\underline{\phi}<\bar{\phi}$), in each state of nature are depicted in Fig. 4. In the figure, $\Delta\overline{w}$ is the difference in working capital investment between good and bad times for a firm with high liquidity needs. $\Delta\underline{w}$ is the similar difference for a firm with low liquidity needs. It is clear in the figure that, as $\Delta\overline{w}>\Delta\underline{w}$, $\overline{w}$ will be more volatile than $\underline{w}$ for any value of p.

How does financial development affect working capital investment in the two sectors? That situation is shown in Fig. 5. An increase in λ, which rotates the $\lambda\theta$ line to the left, increases working capital investment in the bad state in both sectors but leaves unaffected working capital investment in the good state. The change in the ex ante volatility of working capital investment of sector ϕ resulting from a change in λ from $\underline{\lambda}$ to $\bar{\lambda}$

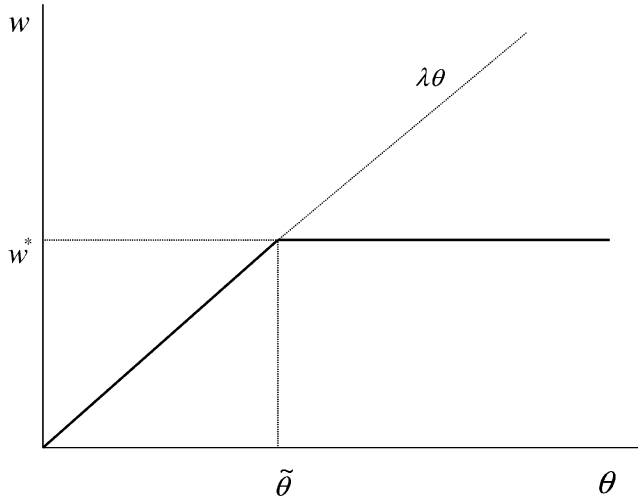

Fig. 3. Optimal working capital investment as a function of the shock θ.

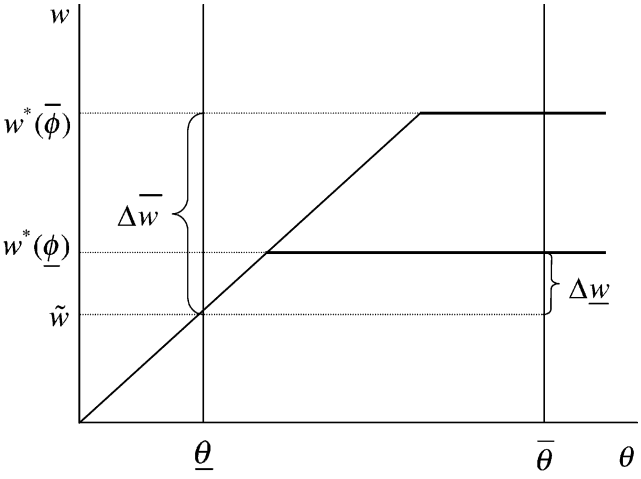

Fig. 4. Difference in working capital investment between good and bad state.

corresponds to

$$\sigma_w^2(\bar{\lambda}) - \sigma_w^2(\underline{\lambda}) = -p(1-p)(\tilde{w}(\bar{\lambda}) - \tilde{w}(\underline{\lambda}))(2\bar{w}^*(\phi) - (\tilde{w}(\bar{\lambda}) - \tilde{w}(\underline{\lambda}))), \tag{A.2}$$

where $\tilde{w}(\bar{\lambda})$ and $\tilde{w}(\underline{\lambda})$ are the constrained investments (which occur when $\theta = \underline{\theta}$) under high and low financial development, respectively, and $\bar{w}^*(\phi)$ is the unconstrained working capital investment of sector ϕ, which occurs in the good state $\bar{\theta}$ (see Eq. (A.1)).

Because the unconstrained investment is increasing in the level of liquidity needs ($\bar{w}^*(\bar{\phi}) > \bar{w}^*(\underline{\phi})$), it can be easily verified from Eq. (A.2) that the fall in the volatility of w in the high-liquidity-needs sector is larger than in the low-liquidity-needs sector. Moreover, as $Y_{w\phi} > 0$, *output* volatility also falls relatively more in the high-liquidity-needs sector. In

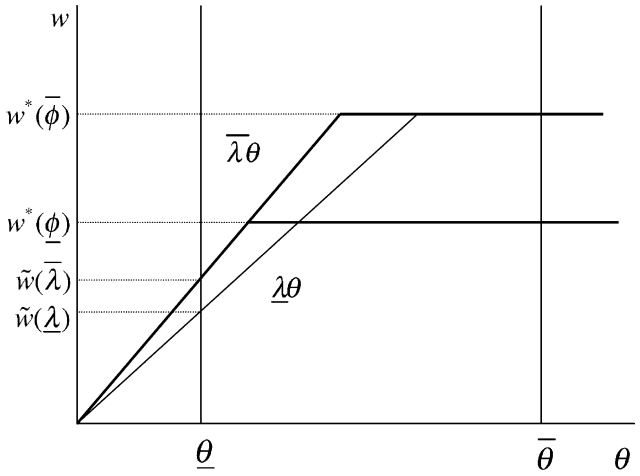

Fig. 5. Financial development and sector volatilities.

conclusion, the model predicts that an increase in financial development reduces the relative volatility of the sector with high liquidity needs. This result may be reversed if a sector with high liquidity needs is financially constrained during good times. Of course, the dichotomy between good and bad times is just a simplification. The "good state" represents those states of nature in a continuous distribution in which firms are not financially constrained. The use of a continuous distribution of shocks does not affect the main results. Also, from a practical standpoint, the assumption of no financial constraints in the good state is equivalent to assuming that financial development is not too low. Given that data on sector output are typically unavailable for countries with very low levels of financial development, this assumption is likely to hold in the empirical setup. A more important condition for the result is that the cash flow shock θ represents a nominal shock, not a real one. When θ represents a productivity shock, the relation between financial development and relative output volatility can fail under some parameterizations.

The intuition behind the result is as follows: working capital is a more important input in sectors with high liquidity needs. Therefore, the inability to invest in working capital during bad times because of financial constraints affects the production of firms with high liquidity needs relatively more. For this reason, the partial relaxation of these constraints resulting from an increase in financial development benefits these firms relatively more. In other words, the shadow price of financial development is higher for firms with high liquidity needs.

Appendix B. Effect on aggregate manufacturing volatility

As discussed in Section 6.1, if a change in financial development (F) does not affect the productive structure (the w_i's) or the correlations across sectors (ρ_{ij}), then the effect of

financial development on aggregate manufacturing volatility is given by

$$\frac{\mathrm{d}\sigma}{\mathrm{d}F} = \frac{1}{2\sigma}\sum_i \sum_j w_i w_j \rho_{ij}\left(\frac{\mathrm{d}\sigma_i}{\mathrm{d}F}\,\sigma_j + \sigma_i\,\frac{\mathrm{d}\sigma_j}{\mathrm{d}F}\right). \tag{B.1}$$

The parameter γ, estimated in the regressions, is akin to the cross-derivative of sector volatility with respect to financial development and liquidity needs: $\gamma = (\partial^2\sigma_i/\partial L\partial F)$. The total effect of financial development on sector volatility ($\mathrm{d}\sigma_i/\mathrm{d}F$) thus corresponds to

$$\frac{\mathrm{d}\sigma_i}{\mathrm{d}F} = \gamma(L_i - L_0) + \frac{\mathrm{d}\sigma_0}{\mathrm{d}F},$$

where σ_0 is the volatility of a baseline sector for which the total effect of financial development is known. Replacing this expression into Eq. (B.1) we obtain the formula used to compute the aggregate effect of financial development:

$$\begin{aligned}\frac{\mathrm{d}\sigma}{\mathrm{d}F} = {} & \frac{\gamma}{2\sigma}\sum_i \sum_j w_i w_j \rho_{ij}((L_i - L_0)\sigma_j + \sigma_i\,(L_j - L_0)) \\ & + \frac{\sigma_{0F}}{2\sigma}\sum_i \sum_j w_i w_j \rho_{ij}(\sigma_j + \sigma_i).\end{aligned} \tag{B.2}$$

In the paper, this expression is evaluated assuming that financial development has no effect on the volatility on the sector with the lowest liquidity needs ($\sigma_{0F} = 0$) and using the average values of the sector shares and correlations across countries.

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